The New Brunswick
Electric Power Commission

ENVIRONMENTAL RADIATION MONITORING DATA FOR POINT LEPREAU GENERATING STATION

January 01, 1989 to December 31, 1989

Health Physics Department

93-02564/

ENVIRONMENTAL RADIATION MONITORING DATA FOR POINT LEPREAU GENERATING STATION

January 01, 1989 to December 31, 1989

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Health Physics Department
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EXECUTIVE SUMMARY

This report, issued annually, is a compilation of the 1989 Environmental Radiation Monitoring Program data collected around the Point Lepreau Generating Station (PLGS) and at reference locations remote from PLGS.

In 1989, about 1420 analyses were made on 1000 samples to monitor environmental radiation in the vicinity of Point Lepreau and across the province in general. Samples include: air particulates, water vapour, carbon dioxide in air, sea water, well water, milk, beach sediments, clams, fish, lobster, dulse, crabs, periwinkles, scallops, sea plants and lichen. Background radiation is measured by thermo-luminescence dosimetry. A major component of natural background radiation - radon and its daughters - detected in many samples, is not assessed in this program. Though radon is now recognized as a potential radiation hazard to the general public when concentrated in dwellings, its sporadic and variable occurrence has nothing to do with PLGS and it is outside of the scope of this program.

The data indicate that radionuclide emissions from PLGS in 1989, as in previous years, continue to be well below 1% of the regulatory limits.

The only assessable radiation dose from PLGS on the local population to the present time, is that from tritiated water vapour in air. This dose is calculated to be less than 0.7 microsievert per annum at the exclusion zone boundary at 1 km from the station. Natural radiation in the area contributes more than 2 000 times this dose. An insignificant additional dose contribution of about 0.07 microsievert per annum is calculated to occur through the consumption of large quantities of seafood, all of which contain relatively high concentrations of natural radioactivity (for example K-40) giving a much higher, but still insignificant radiation dose. Despite detection limits that approach 1E-18 of a gram (about a billion times more sensitive than can be achieved by the most sensitive chemical analyses) none of the emitted radionuclides in the liquid effluent pathway has been detected in any seafood sample.

INDEX

		Page
	EXECUTIVE SUMMARY	3
1.0	INTRODUCTION	7
2.0	SAMPLE LOCATIONS	13
3.0	SUMMARY TABLES OF ENVIRONMENTAL DATA	21
4.0	DISCUSSION OF ENVIRONMENTAL DATA	69
5.0	QUALITY CONTROL AND QUALITY ASSURANCE	79

APPENDICES

6.0	SOURCE EMISSION DATA FROM POINT LEPREAU G.S.	95
7.0	METEOROLOGICAL DATA AROUND POINT LEPREAU G.S.	105
8.0	STATISTICS, ANALYTICAL TECHNIQUES, SAMPLE COLLECTION	113
9.0	ENVIRONMENTAL REPORTS OF PREVIOUS YEARS	127
10.0	DISTRIBUTION LIST	129

1.0 INTRODUCTION

The Environmental Radiation Monitoring Program for PLGS fulfils several objectives. These are:

1. To define the background levels of radiation in the area, whether naturally occurring, from weapons testing fallout or from other sources not related to PLGS (e.g., the accident at Chernobyl).

2. To provide an early indication of the appearance of any radioactive material in the environment caused by the operation of PLGS and to verify that all significant pathways through the environment are identified.

3. To verify the adequacy and proper functioning of Station effluent controls and monitoring systems.

4. To provide an estimate of actual radiation exposure to the surrounding population from the operation of PLGS based upon the analyses of environmental samples.

5. To provide assurance to the Atomic Energy Control Board (AECB - the regulating body for nuclear facilities), and to the general public that the station's environmental impact is comprehensively defined and is within anticipated limits.

Since 1976, the environmental radiation monitoring program has analyzed environmental samples to define background radiation, whether natural or from bomb tests, prior to the operation of PLGS in 1982. The analytical program detected and monitored radionuclide fallout in New Brunswick after a Chinese bomb test in 1980 and, most recently, fallout from the reactor accident at Chernobyl in the USSR in April of 1986.

The effectiveness of the radiation monitoring program is evaluated at least annually. This ensures that the samples collected, their frequency of collection and the analytical techniques are appropriate to achieve the aims and objectives of the program.

The capability of the radiation monitoring laboratory is continuously assessed through participation of the laboratory in a Quality Assurance analysis program administered by the U.S. Environmental Protection Agency (EPA) in Nevada. The EPA provides samples for blind analysis as described in Section 5.

The data contained in this report were collected over the period from January 01, 1989 to December 31, 1989. During this time, the major sample types analyzed and their frequency of collection were as indicated in Table 1.01.

As emissions from PLGS have been at less than 1% of the Derived Emission Limits (DELs) since startup, the frequency of collection is at Level 1, as shown in column 2 (<1% DEL) of this table.

TABLE 1.01

SCHEDULE OF SAMPLE COLLECTION AND ANALYSIS

SAMPLE TYPE OR SURVEY	LEVEL 1 FREQUENCY <1% DEL (1)	LEVEL 2 FREQUENCY 1-10% DEL	LEVEL 3 FREQUENCY >10% DEL
Air Particulate (2)	Monthly	Weekly	Weekly
Air Iodine (2)	Monthly	Weekly	Weekly
Air Tritium (2) and Carbon-14 (2)	Monthly	Weekly	Weekly
TLD (2)	Quarterly	Monthly	Monthly
Sediment	Quarterly	Monthly	Monthly
Beach Survey	Quarterly	Monthly	Weekly
Ground Water (Well, Surface)	Semi-annually	Quarterly	Monthly
Sea Water	Quarterly	Monthly	Monthly
Milk	Quarterly (3) Monthly (4)	Monthly	Monthly
Seafood (Clams, Scallops, Dulse, Crabs, Lobster, Fish, Periwinkles)	Semi-annually	Monthly	Weekly
	---------- As available ----------		

(1) DEL means Derived Emission Limit.
(2) Integrated sample.
(3) From selected dairy herds in southern N.B.
(4) Commercial dairy milk sample.

All radionuclide analyses (approximately 1 400 measurements) were carried out in the Health Physics Environmental Laboratory at 420 York Street, Fredericton, N.B.

In 1989, the only environmental samples which contained detectable radionuclides emitted from PLGS were:

1. Airborne water vapour samples and well waters containing tritium.

2. Parshall flume and borehole waters from the Solid Radioactive Waste Management Facility (SRWMF) on the PLGS site, containing tritium.

3. Lagoon waters from the PLGS site, containing tritium.

4. Seawater samples containing tritium.

Outside the 1 km boundary, the activity of tritium in air as measured by airborne water vapour samples ranges from less than 0.1 Bq/m^3 (i.e., not detected) up to about 4 Bq/m^3 of air.

The Point Lepreau Generating Station was declared in Commercial Operation on January 31, 1983. The Gross Capacity Factors, indicating the level of operation over the last seven years, are tabulated below:

TABLE 1.02

PLGS PRODUCTION PERFORMANCE

	1983 %	1984 %	1985 %	1986 %	1987 %	1988 %	1989 %
Gross Capacity Factor	85.7	89.7	97.4	94.0	91.8	95.7	94.8

In 1989, as in all previous years, radionuclide emissions have remained well below target levels of 1% of the combined DELs in each emission pathway.

The numbers of environmental samples processed in each category over the last eight years are as shown below:

TABLE 1.03

SAMPLE INFORMATION

Sample Type	Number of Samples Analyzed each year							
	1982	1983	1984	1985	1986	1987	1988	1989
AC Air C-14	2	11	13	28	24	26	24	34
AI Air Iodine	260	363	208	208	208	206	174	96
AP Air Particulate	260	363	208	207	208	206	174	96
AT Air Tritium	72	94	101	104	104	104	92	96
BH Bore Hole	10	30	24	18	12	12	12	12
CL Clams	6	7	12	13	11	13	11	11
CR Crabs	--	--	1	2	1	3	3	2
DU Dulse	1	7	7	9	8	7	7	3
FI Fish	21	14	16	13	14	18	12	9
LO Lobster	5	5	7	8	7	9	9	7
LS Lagoon Sludge	--	2	--	--	11	0	0	0
LW Lagoon Water	--	2	22	33	38	37	36	35
MI Milk	19	20	19	20	28	17	19	20
PE Periwinkles	--	--	3	4	5	4	0	7
PF Parshall Flume	10	44	47	67	57	52	51	51
QA Quality Ass.	21	21	24	30	33	33	33	19
SC Scallops	--	3	7	8	6	2	3	6
SE Sediment	40	40	41	41	45	42	40	40
SO Soil	2	--	--	4	--	--	--	--
SP Sea Plant	--	--	4	8	13	15	11	10
SW Sea Water	16	17	18	17	18	19	18	18
VG Vegetation	2	13	13	13	33	13	14	14
WW Well Water	18	18	18	18	20	20	22	20
ZZ Miscellaneous	12	34	120	155	186	213	231	204
TLD	95	115	120	119	131	143	146	150
BS Beach Surveys	40	40	40	40	40	40	40	40

The miscellaneous samples include those which do not readily fit into any of the above categories or are not routinely collected. These include vegetation other than lichen or moss, berries, swamp water, rainwater, pond water and numerous in-station samples relating to the operation of PLGS.

Other programs in place to monitor environmental samples from the Point Lepreau area are conducted by:

1. The Department of Health in New Brunswick.

2. The Bedford Institute of Oceanography (BIO), in Dartmouth, Nova Scotia.

3. The Federal Department of Health and Welfare in Ottawa.

Analytical results reported by the various agencies are generally comparable.

2.0 SAMPLE LOCATIONS

The major sample locations are shown in Figures 2.1 to 2.6. Each 'Indicator' station has a three or four-character identification code (e.g., F01, I00A). An indicator station is one within the possible influence of PLGS emissions. 'Reference' locations, chosen to lie outside the influence of PLGS operations, are identified by the letter R at the end of the location code (e.g., A01R).

Sampling locations for mobile seafood species (lobster, fish, etc.) caught in the Point Lepreau area are specified as accurately as reasonably possible. The location of capture, however, may bear little relationship to where the animal has been, except for the 'Jonah' crabs which are caught near the PLGS cooling water outflow. With the exception of Reference location samples, all seafood samples analyzed are either purchased from local fishermen who made their catch in the Point Lepreau area or are collected by laboratory staff. Reference samples are purchased from fishermen or suppliers who fish outside of the Bay of Fundy region, for example from Chaleur Bay or the Northumberland Strait.

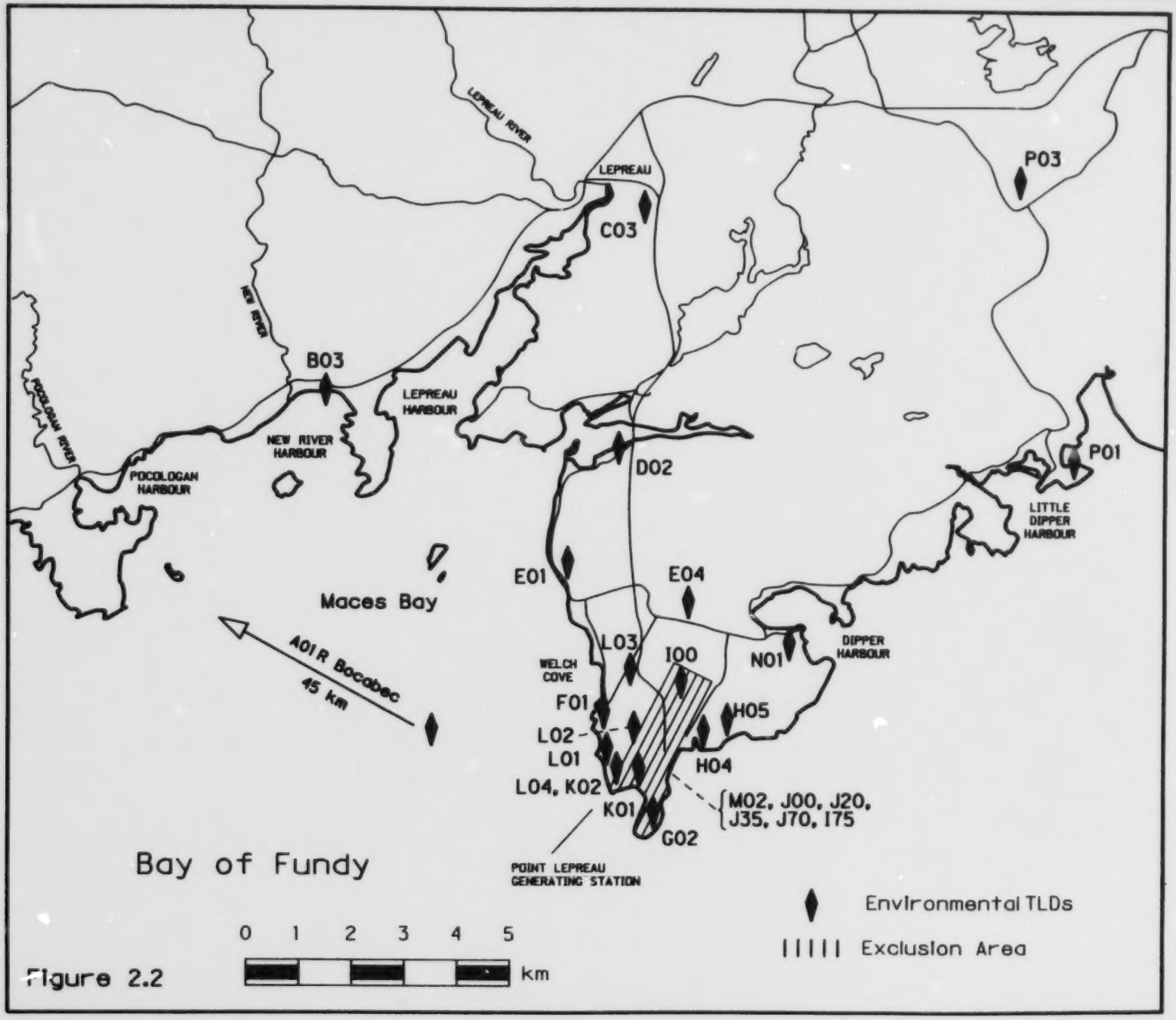

LEPREAU RIVER
LEPREAU
C03
P03
NEW RIVER
B03
LEPREAU HARBOUR
POCOLOGAN RIVER
NEW RIVER HARBOUR
POCOLOGAN HARBOUR
D02
P01
LITTLE DIPPER HARBOUR
E01
E04
Maces Bay
A01R Bocabec
45 km
L03
I00
N01
DIPPER HARBOUR
WELCH COVE
F01
H05
L02
L01
H04
L04, K02
K01
G02
M02, J00, J20, J35, J70, I75
POINT LEPREAU GENERATING STATION
Bay of Fundy
Environmental TLDs
Exclusion Area
0 1 2 3 4 5
km

Figure 2.2

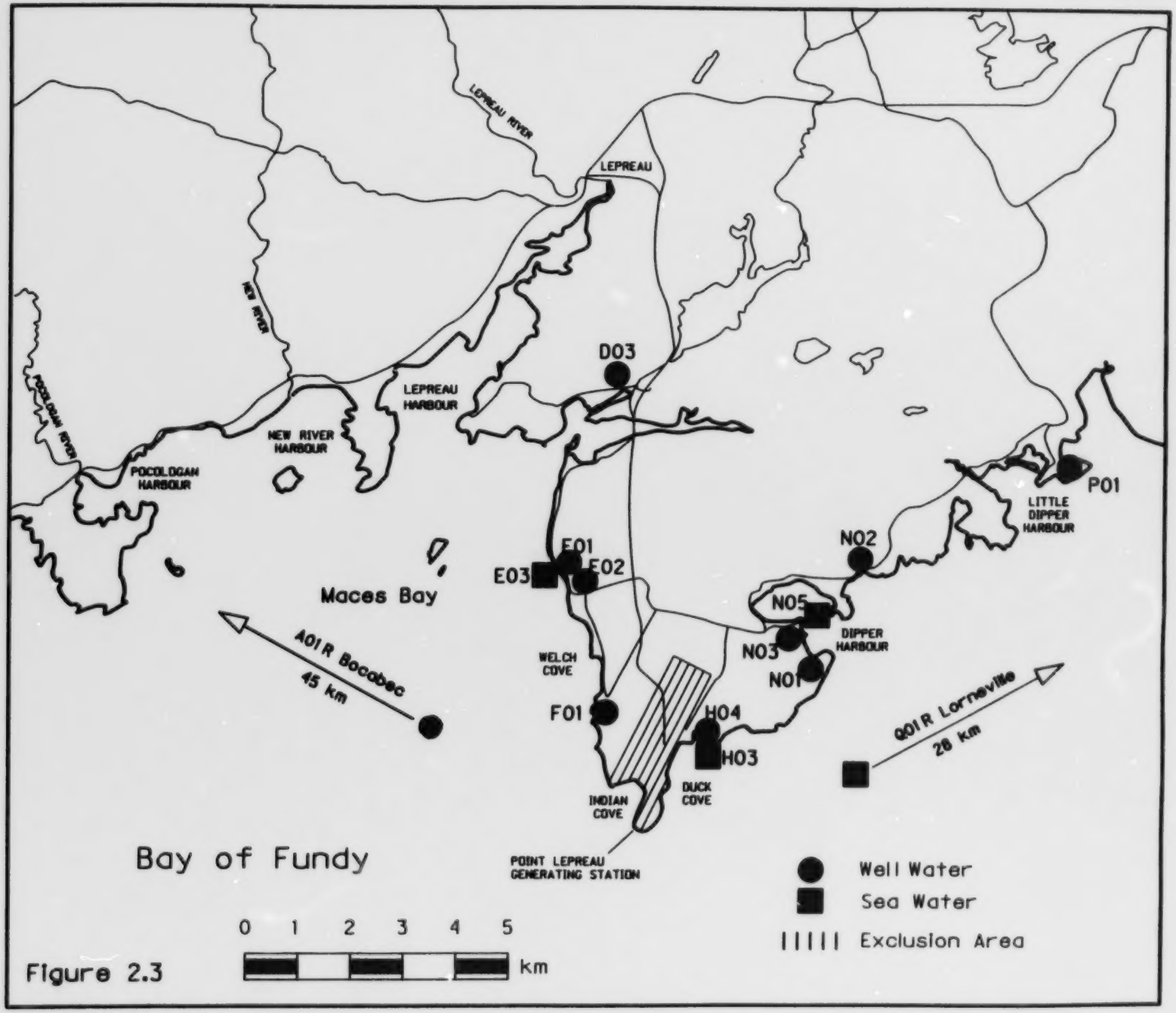

LEPREAU RIVER
LEPREAU
NEW RIVER
POCOLOGAN RIVER
D03
LEPREAU HARBOUR
NEW RIVER HARBOUR
POCOLOGAN HARBOUR
P01
LITTLE DIPPER HARBOUR
N02
E01
E02
E03
Maces Bay
N05
DIPPER HARBOUR
N03
N01
WELCH COVE
A01R Bocabec
45 km
F01
H04
H03
Q01R Lorneville
28 km
INDIAN COVE
DUCK COVE
POINT LEPREAU GENERATING STATION
Bay of Fundy
Well Water
Sea Water
Exclusion Area
0 1 2 3 4 5
km

Figure 2.3

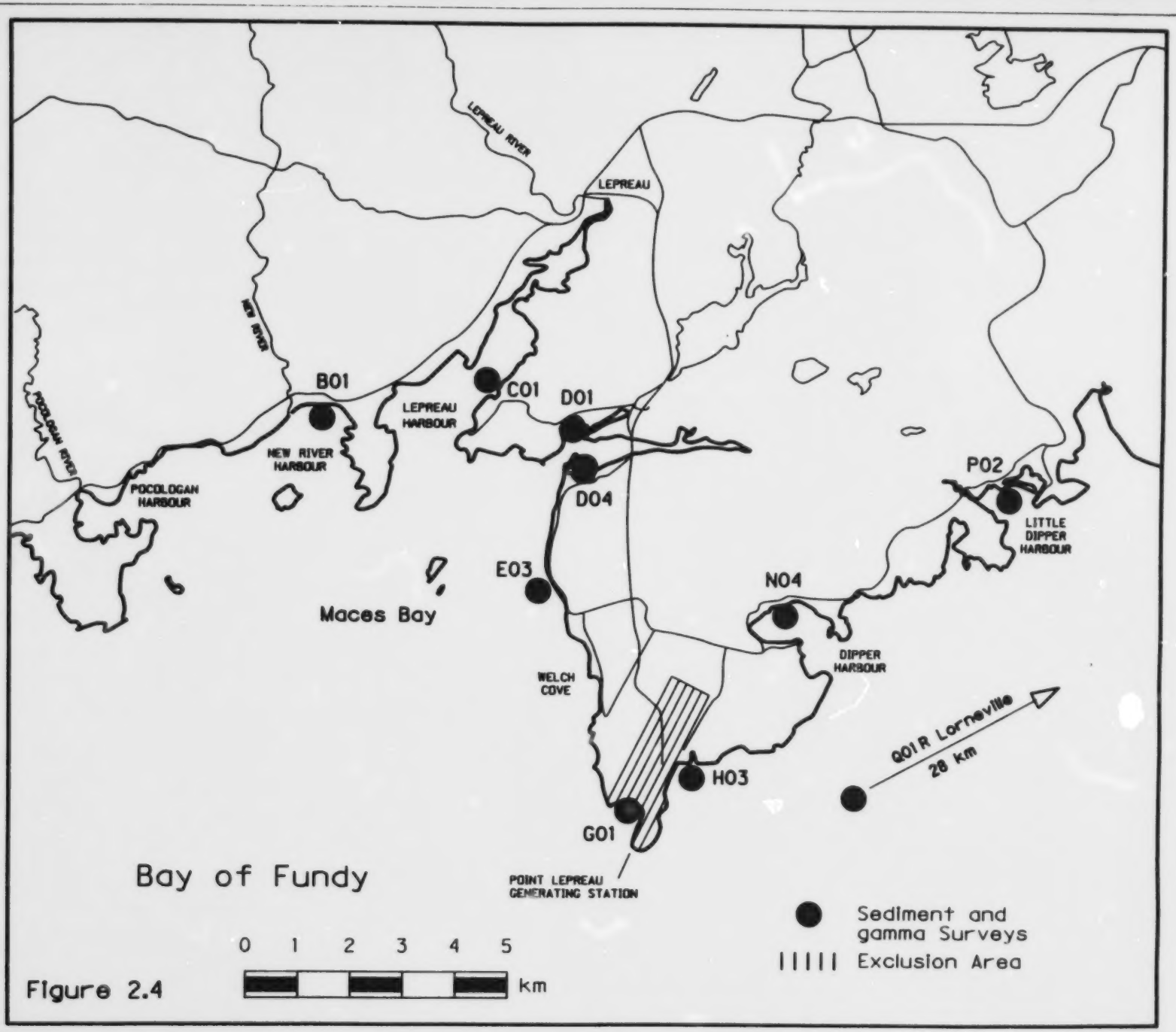

LEPREAU RIVER
LEPREAU
NEW RIVER
POCOLOGAN RIVER
B01
C01
D01
LEPREAU HARBOUR
NEW RIVER HARBOUR
POCOLOGAN HARBOUR
D04
P02
LITTLE DIPPER HARBOUR
E03
N04
Maces Bay
DIPPER HARBOUR
WELCH COVE
Q01R Lorneville
28 km
H03
G01
POINT LEPREAU GENERATING STATION
Bay of Fundy
Sediment and gamma Surveys
Exclusion Area
0 1 2 3 4 5
km

Figure 2.4

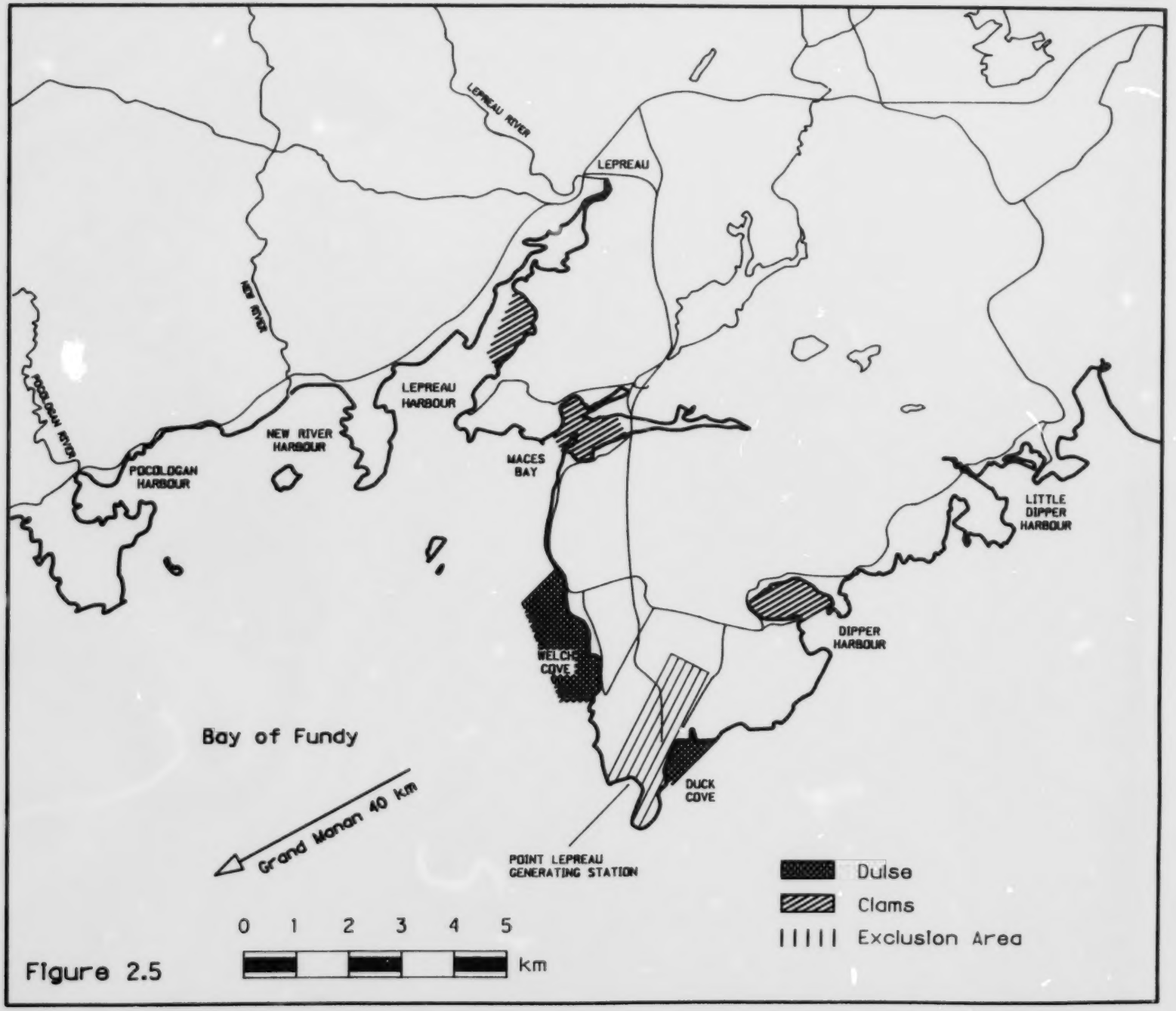

LEPREAU RIVER
LEPREAU
NEW RIVER
POCOLOGAN RIVER
LEPREAU HARBOUR
NEW RIVER HARBOUR
POCOLOGAN HARBOUR
MACES BAY
LITTLE DIPPER HARBOUR
DIPPER HARBOUR
WELCH COVE
DUCK COVE
Bay of Fundy
Grand Manan 40 km
POINT LEPREAU GENERATING STATION
Dulse
Clams
Exclusion Area
0 1 2 3 4 5
km

Figure 2.5

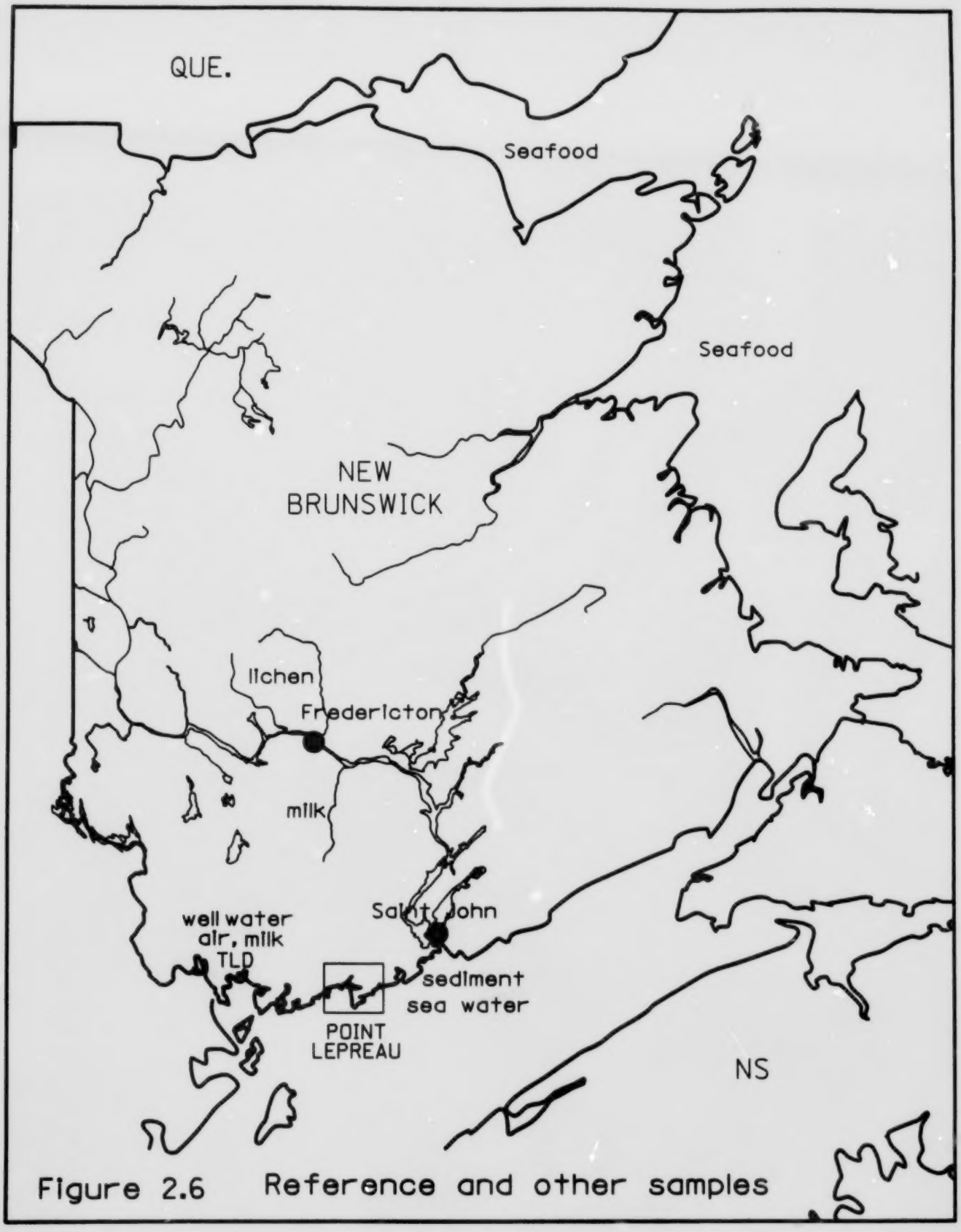


Figure 2.6 Reference and other samples

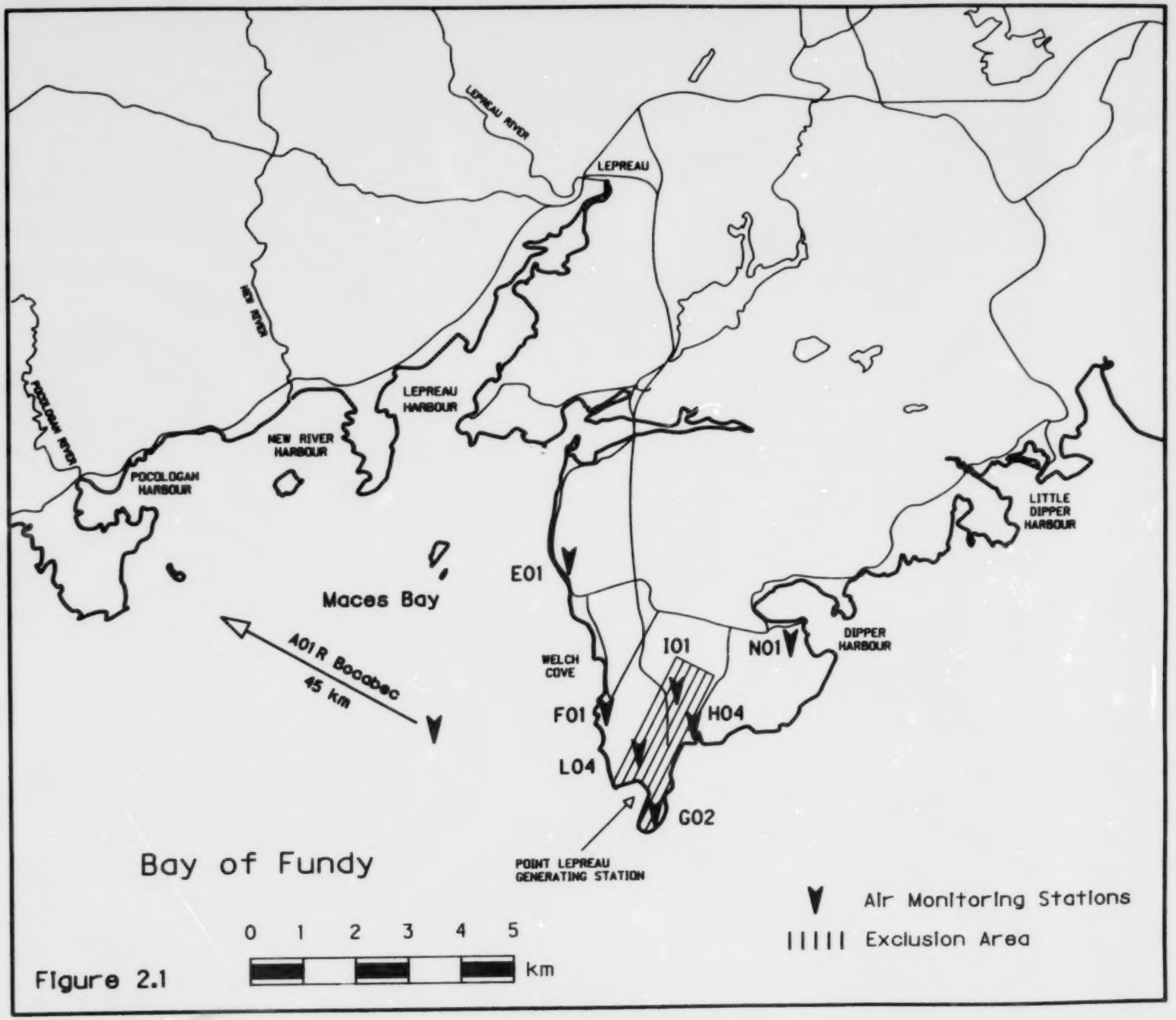

LEPREAU RIVER
LEPREAU
NEW RIVER
POCOLOGAN RIVER
LEPREAU HARBOUR
NEW RIVER HARBOUR
POCOLOGAN HARBOUR
LITTLE DIPPER HARBOUR
E01
Maces Bay
A01R Bocabec
45 km
WELCH COVE
I01
N01
DIPPER HARBOUR
F01
H04
L04
G02
POINT LEPREAU GENERATING STATION
Bay of Fundy
Air Monitoring Stations
Exclusion Area
0 1 2 3 4 5
km

Figure 2.1

3.0 SUMMARY TABLES OF ENVIRONMENTAL DATA

The following tables provide a summary of the environmental data collected during the period January 01, 1989 to December 31, 1989.

Table #		Page #
3.01	Airborne Particulates.	24
3.02	Airborne Radioiodines.	26
3.03A	Airborne Tritium.	27
3.03B	Airborne Tritium, detailed.	28
3.03C	Airborne Tritium, previous years.	29
3.04A	Airborne Carbon-14.	30
3.04B	Airborne Carbon-14, by location.	31
3.05A	Environmental TLDs.	32
3.05B	Environmental TLDs, summary 1978-1989.	33
3.06	Environmental Gamma Surveys.	34
3.07A	Cs-137 in Sediment, summary 1978-1989.	35
3.07B	Sediment.	36
3.08	Well Water.	38
3.09	Bore Hole Water (SRWMF).	40
3.10	Parshall Flume (SRWMF).	42
3.11	Lagoon Water (PLGS Site).	44
3.12	Sea Water.	46
3.13	Milk.	48
3.14	Clams.	50
3.15	Crab.	52
3.16	Dulse.	54
3.17	Fish.	56
3.18	Lobster.	58
3.19	Periwinkles.	60
3.20	Scallops.	62
3.21	Sea Plants, (various seaweeds).	64
3.22	Vegetation.	66

Most tables contain the following data:

Column 1 - Shows the type of analysis or nuclide and, in parentheses, the total number of samples analysed.

Column 2 - Shows the mean of the Critical Levels (CLs) for all samples and, in parentheses, the range of the CLs. Any measurement greater than the CL is considered detected at the 99% confidence level, (explanation of the statistical protocol is given in Section 8).

Column 3 - Shows the mean of the detected values (i.e., values exceeding the CL) for all indicator stations, followed in parentheses by the ratio (F) of the number of detected values to the total number of indicator samples. Values less than or equal to the CL are not included in the mean. The second line of the column indicates the range of detected values for the indicator stations.

Column 4 - Shows the location code for the indicator station with the largest mean value. Refer to the maps of Section 2 for sample locations.

Column 5 - Shows the mean of detected values for the indicator station with the largest value, followed in parentheses by the ratio (F) of the number of detected values to the total number of samples for this indicator station. The second line of this column contains the range of detected values for this location.

Column 6 - Shows the mean of detected values at the Reference location(s), followed in parentheses by the ratio (F) of detected values to the total number of samples at this location. The second line of this column contains the range of detected values for the Reference location(s).

SUMMARY TABLES OF DATA

TABLE 3.01 90-03-12

Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

Airborne Particulate, Filter Bq/m3

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Mean (F) (Range)	Reference Station Mean (F) (Range)
ALPHA (96)	3.6E-006 (1.4E-006 - 1.5E-005)	2.8E-005 (83/84) (6.7E-006 - 5.7E-005)	I01	3.4E-005 (12/12) (8.5E-006 - 5.7E-005)	3.6E-005 (12/12) (1.8E-005 - 5.9E-005)
BETA (96)	9.7E-006 (3.6E-006 - 4.1E-005)	3.7E-004 (84/84) (4.8E-005 - 8.2E-004)	I01	4.4E-004 (12/12) (1.2E-004 - 8.2E-004)	4.3E-004 (12/12) (2.3E-004 - 7.0E-004)
Ce-144 (96)	1.3E-004 (5.9E-005 - 5.1E-004)	*		*	*
Ce-141 (96)	4.2E-005 (1.9E-005 - 2.0E-004)	*		*	*
Cr-51 (96)	3.2E-004 (1.3E-004 - 1.8E-003)	*		*	*
I-131 (96)	1.0E-004 (3.1E-005 - 2.0E-003)	*		*	*
Be-7 (96)	3.1E-004 (1.0E-004 - 1.4E-003)	2.0E-003 (80/84) (4.4E-004 - 6.4E-003)	F01	2.5E-003 (12/12) (1.4E-003 - 6.4E-003)	2.3E-003 (12/12) (1.5E-003 - 2.9E-003)
Ru-103 (96)	3.6E-005 (1.4E-005 - 1.4E-004)	*		*	*
Ba-140 (96)	2.3E-004 (8.7E-005 - 2.2E-003)	*		*	*
Cs-134 (96)	2.9E-005 (9.6E-006 - 1.1E-004)	*		*	*
Ru-106 (96)	2.8E-004 (9.1E-005 - 1.4E-003)	*		*	*
Cs-137 (96)	3.0E-005 (1.2E-005 - 9.8E-005)	*		*	*
Zr-95 (96)	5.7E-005 (1.8E-005 - 2.7E-004)	*		*	*
Nb-95 (96)	3.4E-005 (1.1E-005 - 1.6E-004)	*		*	*

TABLE 3.01 (Cont'd)
Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

90-03-12

Airborne Particulate, Filter Bq/m3

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Highest Indicator Station Mean (F) (Range)	Reference Station Mean (F) (Range)
Co-58 (96)	3.1E-005 (1.1E-005 - 1.2E-004)	*		*	*
Mn-54 (96)	3.0E-005 (1.1E-005 - 1.4E-004)	*		*	*
Ag-110m (96)	4.1E-005 (1.1E-005 - 1.9E-004)	*		*	*
Ac-228 (96)	1.2E-004 (4.2E-005 - 5.6E-004)	2.1E-004 (1/84) (2.1E-004 - 2.1E-004)	H01	2.1E-004 (1/12) (2.1E-004 - 2.1E-004)	*
Fe-59 (96)	8.0E-005 (2.3E-005 - 3.5E-004)	*		*	*
Zn-65 (96)	6.8E-005 (1.6E-005 - 4.1E-004)	*		*	*
Co-60 (96)	3.8E-005 (1.3E-005 - 1.9E-004)	*		*	*
K-40 (96)	5.8E-004 (1.6E-004 - 2.6E-003)	7.4E-004 (3/84) (5.3E-004 - 9.5E-004)	H04	9.5E-004 (1/12) (9.5E-004 - 9.5E-004)	*
La-140 (96)	8.3E-005 (3.1E-005 - 5.3E-004)	*		*	*

* : The activity is less than or equal to the Critical Level (99% Confidence Level).

F : Number of analyses greater than the Critical Level/Total number of analyses.

TABLE 3.02 90-03-12
Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

Airborne Iodine, Char. Cart. Bq/m3

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Mean (F) (Range)	Reference Station Mean (F) (Range)
I-131 (96)	1.6E-005 (9.8E-006 - 3.5E-005)	*		*	*

* : The activity is less than or equal to the Critical Level (99% Confidence Level).

F : Number of analyses greater than the Critical Level/Total number of analyses.

TABLE 3.03A

90-03-12

Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

Airborne Tritium, Sieve Bq/m3

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Mean (F) (Range)	Reference Station Mean (F) (Range)
H-3	1.0E-001	1.2E+000 (69/84)	H04	2.7E+000 (12/12)	*
(96)	(1.8E-002 - 5.2E-001)	(4.0E-002 - 5.3E+000)		(5.3E-001 - 5.3E+000)	

* : The activity is less than or equal to the Critical Level (99% Confidence Level).

F : Number of analyses greater than the Critical Level/Total number of analyses.

TABLE 3.03B 90-03-12

Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

Airborne Tritium, Sieve Bq/m3

Collection Start Date +	A01R Bocabec ## 45	E01 Maces Bay 4.5	F01 Welch Cove 1.5	G02 Lepreau Lighthouse 1.0	H04 Information Centre 0.75	I01 SRWMF 1.0	L04 Construction Stores 0.6	N01 Dipper Harbour 3.8
89-01-11	< 2.5E-002	< 2.9E-002	1.3E-001	2.9E-001	1.2E+000	9.9E-001	5.7E-001	1.0E-001
89-02-08	< 2.6E-002	< 3.7E-002	< 5.2E-002	3.7E-001	2.1E+000	9.3E-001	6.3E-001	1.9E-001
89-03-07	< 3.6E-002	< 4.0E-002	1.1E-001	6.3E-001	2.3E+000	1.2E+000	7.3E-001	2.8E-001
89-04-05	< 6.2E-002	1.9E-001	4.4E-001	5.4E-001	4.8E+000	1.9E+000	2.2E+000	8.6E-001
89-05-10	< 2.1E-001	< 1.7E-001	7.2E-001	5.2E-001	4.0E+000	1.5E+000	2.8E+000	1.5E+000
89-06-07	< 2.3E-001	< 2.9E-001	4.0E-001	1.9E+000	2.0E+000	2.0E+000	1.3E+000	4.1E-001
89-07-06	< 3.7E-001	< 2.0E-001	4.4E-001	4.8E-001	5.3E+000	3.7E+000	4.6E-001	1.1E+000
89-08-03	< 3.0E-001	< 2.4E-001	2.2E-001	< 5.1E-001	4.7E+000	3.8E+000	6.5E-001	6.5E-001
89-09-06	< 1.9E-001	< 1.2E-001	1.4E-001	3.6E-001	2.9E+000	2.4E+000	7.2E-001	4.9E-001
89-10-02	< 6.3E-002	< 8.8E-002	1.4E-001	5.6E-001	2.0E+000	9.7E-001	1.3E+000	3.5E-001
89-11-03	< 4.0E-002	< 4.0E-002	< 6.6E-002	3.4E-001	6.3E-001	1.3E+000	3.1E-001	< 7.3E-002
89-12-14	< 2.6E-002	< 3.7E-002	7.8E-002	1.1E-001	5.3E-001	7.9E-001	1.9E-001 *	4.0E-002

\+ : The sample collection periods are approximately four weeks in duration, so there are between 12 and 13 periods in the year. All sample stations are changed at the same time. The start date is the stop date for the previous sample.

: Approximate distance from the PLGS stack (km).

* : Collection Start Date is later than that indicated.

SRWMF - Solid Radioactive Waste Management Facility

TABLE 3.03C 90-03-12

Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
76-01-01 to 89-12-31

Airborne Tritium, Sieve Bq/m3

Year Samples Analysed	Critical Level Mean (Range)	Indicator Stations Mean(F) (Range)	Reference Station Mean(F) (Range)
1976 to 1979 95	7.5E-2 (1.1E-3 to 2.1E-1)	1.3E-1 (18/75) (3.4E-3 to 5.6E-1)	2.2E-1 (4/20) (2.6E-2 to 7.2E-1)
1980 56	9.9E-2 (2.6E-2 to 3.3E-1)	3.7E-1 (15/44) (8.5E-2 to 3.0E+0)	2.2E-1 (2/12) (8.9E-2 to 3.4E-1)
1981 52	9.2E-2 (1.3E-2 to 2.4E-1)	1.9E-1 (3/46) (1.2E-1 to 3.3E-1)	7.6E-1 (2/6) (4.3E-1 to 1.1E+0)
1982 72	5.7E-2 (2.2E-2 to 5.2E-1)	2.2E-1 (18/62) (2.6E-2 to 2.0E+0)	4.9E-2 (2/10) (3.7E-2 to 6.1E-2)
1983 94	4.5E-2 (2.0E-2 to 1.7E-1)	2.4E-1 (52/82) (3.4E-2 to 1.3E+0)	1.7E-1 (4/12) (8.0E-2 to 2.7E-1)
1984 101	1.0E-1 (2.3E-2 to 2.7E-1)	7.1E-1 (73/88) (6.0E-2 to 5.6E+0)	1.4E-1 (2/13) (1.0E-1 to 1.8E-1)
1985 104	7.5E-2 (1.4E-2 to 2.8E-1)	5.7E-1 (77/91) (1.5E-2 to 3.3E+0)	8.0E-2 (1/13) (8.0E-2 to 8.0E-2)
1986 104	1.1E-1 (1.2E-2 to 5.1E-1)	1.3E+0 (81/91) (5.2E-2 to 9.1E+0)	1.3E-1 (1/13) (1.3E-1 to 1.3E-1)
1987 104	7.9E-2 (1.1E-2 to 4.7E-1)	1.0E+0 (76/91) (3.7E-2 to 6.4E+0)	1.0E-1 (1/13) (1.0E-1 to 1.0E-1)
1988 92	9.8E-2 (2.4E-2 to 3.1E-1)	1.3E+0 (75/80) (4.8E-2 to 1.1E+1)	4.8E-2 (1/12) (4.8E-2 to 4.8E-2)
1989 96	1.0E-1 (1.8E-2 to 5.2E-1)	1.2E+0 (69/84) (4.0E-2 to 5.3E+0)	* (0/12)

* : The activity is less than or equal to the Critical Level (99% Confidence Level).

F : Number of analyses greater than the Critical Level/Total number of analyses.

TABLE 3.04A

90-03-12

Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

Airborne C-14, Caustic Bubbler Bq/m3

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Mean (F) (Range)	Reference Station Mean (F) (Range)
C-14 (34)	4.9E-001 (1.3E-001 - 3.5E+000)	3.4E-001 (3/24) (2.1E-001 - 5.6E-001)	G02	4.1E-001 (2/12) (2.7E-001 - 5.6E-001)	3.4E-001 (5/10) (2.4E-001 - 4.3E-001)

* : The activity is less than or equal to the Critical Level (99% Confidence Level).

F : Number of analyses greater than the Critical Level/Total number of analyses.

TABLE 3.04B 90-03-12
Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

Airborne C-14, Caustic Bubbler Bq/m3

Collection Start Date +	G02 Lepreau Lighthouse	H04 Information Centre	X03R Fredericton Laboratory
89-01-11	2.7E-001	< 3.8E-001	NA
89-02-08	< 7.6E-001	< 2.0E-001	NA
89-03-07	< 1.7E-001	< 2.8E-001	< 6.3E-001 *
89-04-05	< 2.7E-001	< 2.2E-001	< 4.3E-001 *
89-05-10	< 3.1E-001	< 1.5E-001	3.1E-001 *
89-06-07	< 4.0E-001	< 2.4E-001	2.4E-001 *
89-07-06	< 2.0E-001	< 2.7E-001	3.5E-001 *
89-08-03	5.6E-001	2.1E-001	3.6E-001 *
89-09-06	< 4.4E-001	< 2.1E-001	4.3E-001
89-10-02	< 7.1E-001	< 4.8E-001	< 1.3E-001 *
89-11-09	< 8.5E-001	< 2.8E+000	< 2.9E-001 *
89-12-14	< 3.5E+000	< 9.4E-001	< 4.1E-001 *

+ : The sample collection periods are approximately four weeks in duration, so there are between 12 and 13 periods in the year. The two indicator stations are changed at the same time and the reference station is usually changed within 2 or 3 days after that.

NA : Data Not Available - A sample was not collected at this location during the period.

* : Collection Start Date is later than that indicated.

TABLE 3.05A 90-03-12

Point Lepreau Generating Station

Environmental Radiation Monitoring

Summary of Analyses for the Year

1989

TLD, Environmental uGy +- 10%

Location	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
A01R	210 +- 21	244 +- 24	221 +- 22	166 +- 17	840 +- 40
B03	196 +- 20	236 +- 24	237 +- 24	177 +- 18	850 +- 40
C03	194 +- 19	249 +- 25	262 +- 26	177 +- 18	880 +- 40
D02	193 +- 19	281 +- 28	257 +- 26	183 +- 18	910 +- 50
E01	192 +- 19	219 +- 22	208 +- 21	176 +- 18	800 +- 40
E04	176 +- 18	220 +- 22	209 +- 21	154 +- 15	760 +- 40
E05	187 +- 19	240 +- 24	227 +- 23	167 +- 17	820 +- 40
F01	149 +- 15	190 +- 19	173 +- 17	131 +- 13	640 +- 30
G02	161 +- 16	202 +- 20	189 +- 19	150 +- 15	700 +- 40
H04	317 +- 32	204 +- 20	176 +- 18	138 +- 14	840 +- 40
H05	157 +- 16	206 +- 21	172 +- 17	139 +- 14	670 +- 30
I00A	246 +- 25	334 +- 33	285 +- 29	219 +- 22	1080 +- 60
I00B	270 +- 27	329 +- 33	279 +- 28	217 +- 22	1100 +- 60
I00C	256 +- 26	303 +- 30	290 +- 29	224 +- 22	1070 +- 50
I00D	263 +- 26	317 +- 32	276 +- 28	209 +- 21	1070 +- 50
I00E	244 +- 24	297 +- 30	280 +- 28	202 +- 20	1020 +- 50
I00F	244 +- 24	291 +- 29	276 +- 28	207 +- 21	1020 +- 50
I00G	252 +- 25	295 +- 30	NA	223 +- 22	1030 +- 40
I00H	271 +- 27	314 +- 31	249 +- 25	227 +- 23	1060 +- 50
I00I	255 +- 26	293 +- 29	314 +- 31	207 +- 21	1070 +- 50
I00J	237 +- 24	297 +- 30	275 +- 28	211 +- 21	1020 +- 50
I00K	249 +- 25	305 +- 30	267 +- 27	206 +- 21	1030 +- 50
I00L	242 +- 24	315 +- 32	268 +- 27	209 +- 21	1030 +- 50
I75	229 +- 23	256 +- 26	251 +- 25	186 +- 19	920 +- 50
J00	200 +- 20	263 +- 26	261 +- 26	175 +- 18	900 +- 50
J20	227 +- 23	280 +- 28	255 +- 26	194 +- 19	960 +- 50
J35	209 +- 21	237 +- 24	224 +- 22	180 +- 18	850 +- 40
J70	358 +- 36	363 +- 36	369 +- 37	310 +- 31	1400 +- 70
K01	221 +- 22	258 +- 26	242 +- 24	186 +- 19	910 +- 50
K02	245 +- 24	286 +- 29	263 +- 26	204 +- 20	1000 +- 50
L01	194 +- 19	215 +- 22	222 +- 22	168 +- 17	800 +- 40
L02	255 +- 26	298 +- 30	282 +- 28	201 +- 20	1040 +- 50
L03	163 +- 16	196 +- 20	NA	176 +- 18	710 +- 30
L04	215 +- 22	244 +- 24	233 +- 23	172 +- 17	860 +- 40
M02	287 +- 29	330 +- 33	324 +- 32	273 +- 27	1210 +- 60
N01	229 +- 23	241 +- 24	270 +- 27	197 +- 20	940 +- 50
P01	160 +- 16	172 +- 17	156 +- 16	137 +- 14	630 +- 30
P03	215 +- 22	245 +- 24	241 +- 24	193 +- 19	890 +- 40

NA : Data not Available - Lost or destroyed TLD.

TABLE 3.05B 90-03-12

Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses
1978 - 1989

TLD, Environmental uGy — Annual absorbed dose

Locn.	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
A01R	760	660	660	750	960	840	750	900	850	800	920	840
B03	960	840	740	670	840	820	780	890	880	870	920	850
C03	930	900	850	820	870	910	810	940	890	890	980	880
D02	730	880	810	790	860	890	880	920	920	890	990	910
E01	600	850	670	620	890	740	680	800	840	790	880	800
E04	690	940	800	730	850	710	710	790	740	760	800	760
E05	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	820
F01	730	780	960	790	810	650	600	690	680	690	720	640
G02	760	880	780	690	850	720	690	770	760	800	790	700
H04	560	730	540	590	770	650	650	720	710	730	770	840
H05	750	760	670	640	760	720	680	760	760	740	740	670
I00A	NA	NA	850	780	970	980	930	1090	1020	1050	1140	1180
I00B	NA	NA	960	1040	990	970	970	1110	1080	1080	1150	1100
I00C	NA	NA	840	930	1010	960	1000	1110	1060	1060	1150	1070
I00D	NA	NA	800	920	960	970	950	1090	1070	1030	1120	1070
I00E	NA	NA	830	890	920	950	970	1030	1030	1020	1090	1020
I00F	NA	NA	830	930	900	940	960	1070	1050	1010	1090	1020
I00G	NA	NA	840	960	940	910	910	1100	1030	1020	1130	1030
I00H	NA	NA	850	1000	1010	960	960	1100	1090	1040	1150	1060
I00I	NA	NA	780	970	920	930	910	1070	1020	1020	1080	1070
I00J	NA	NA	890	910	850	880	910	1030	1020	990	1080	1020
I00K	NA	NA	750	820	920	880	920	1030	940	1000	1090	1030
I00L	NA	NA	920	1070	900	960	920	1040	970	1010	1080	1030
I75	NA	NA	NA	NA	NA	NA	NA	NA	1140	940	980	920
J00	NA	NA	NA	NA	NA	NA	NA	NA	960	900	970	900
J20	NA	NA	NA	NA	NA	NA	NA	NA	1000	970	1020	960
J35	NA	NA	NA	NA	NA	NA	NA	NA	900	920	970	850
J70	NA	NA	NA	NA	NA	NA	NA	NA	1580	1410	1470	1400
K01	690	1090	830	790	900	850	820	940	930	930	960	910
K02	NA	NA	NA	NA	NA	830	850	920	950	950	1060	1000
L01	710	880	790	680	830	780	750	850	810	810	870	800
L02	840	1000	870	930	990	920	910	1020	1070	980	1130	1040
L03	550	660	640	570	770	650	630	720	750	750	780	710
L04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	970	860
M02	NA	NA	NA	NA	NA	NA	NA	NA	1180	1250	1330	1210
N01	780	1040	660	680	890	850	800	920	880	930	980	940
P01	560	690	550	490	660	610	580	670	680	670	710	630
P03	710	730	650	680	750	720	690	790	710	760	1020	890

NA : TLDs not used in these locations at this time.

TABLE 3.06 90-03-12
Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Year
1989

Beach Surveys, Ion Chamber uGy/h * Intertidal Zones

Location	Quarter 1	Quarter 2	Quarter 3	Quarter 4
B01	0.09	0.11	0.14	0.17
C01	0.14	0.16	0.09	0.17
D01	0.12	0.10	0.13	0.14
D04	0.10	0.12	0.23	0.18
E03	0.20	0.12	0.15	0.21
G01	0.15	0.24	0.19	0.22
H03	0.14	0.14	0.18	0.16
N04	0.18	0.16	0.10	0.12
P02	0.17	0.11	0.16	0.19
Q01R	0.17	0.22	0.13	0.20

* : Although two decimal places are quoted, none of the determinations has this degree of precision nor of accuracy. The data are quoted to two figures just as they are estimated at each location. They should be regarded as about 0.1 to 0.2 microgray/h.

TABLE 3.07B 90-03-12

Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
1978 to 1989

Cs-137 in Sediment Bq/kg

LOCATION	B01	C01	D01	D04	E03	G01	H03	M04	P02	Q01R
PERIOD	*	+	+	+	*	*	*	*	*	+
1978	<1.3	3.6	7.8	NA	<5.0	<2.1	<1.5	<2.1	<1.6	7.0
1979 #	<0.9	4.9	5.3	6.9	<1.2	<2.6	<1.6	<2.1	<1.2	5.4
1980 #	<1.5	3.0	4.2	11.3	<1.2	<2.5	<1.2	<1.2	<2.3	5.6
1981 #	<1.4	2.4	3.9	9.9	<1.0	<1.4	<1.3	<2.1	<1.2	5.3
1982 #	<1.0	3.5	5.8	6.7	<1.6	<2.9	<1.5	<2.3	<2.1	5.8
1983 #	<1.5	<2.0	4.3	5.8	<1.2	<4.5	<2.2	<3.1	<1.5	<4.6
1984 #	<1.5	<2.8	3.4	7.2	<1.7	<3.3	<1.5	<1.9	<2.0	3.8
1985 #	<1.1	<1.6	3.8	5.7	<1.2	<1.6	<1.5	<1.4	<1.4	<1.8
1986 #	<1.7	2.6	5.0	6.9	<1.3	<1.7	<1.4	3.0	<1.1	<2.8
1987 #	<1.3	3.0	3.4	5.7	<1.2	<2.0	<1.2	<1.5	<1.3	<2.2
1988 #	<1.5	2.0	5.0	4.4	<1.4	<2.2	<1.3	<1.9	<1.7	<2.6
1989 1	<1.2	<2.2	4.9	5.1	<1.6	2.6	<0.8	<1.6	<1.0	<1.5
1989 2	<1.6	2.3	5.4	8.1	<1.4	<2.4	<0.9	<2.1	<1.3	<2.2
1989 3	<1.2	3.1	4.5	10.0	<1.4	<2.1	<0.8	2.7	<1.4	1.9
1989 4	<1.7	<1.9	5.7	11.7	<1.5	<1.1	<1.3	<3.0	<1.0	<2.8

< : not detected.

* : coarse grained sediment.

+ : fine grained sediment.

: average of 4 quarterly samples.

NA : not sampled.

TABLE 3.07B

90-03-12

Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

Sediment Bq/kg

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Highest Indicator Station Mean (F) (Range)	Reference Station Mean (F) (Range)
Ce-144 (40)	6.4E+000 (4.4E+000 - 1.2E+001)	*		*	*
Ce-141 (40)	1.6E+000 (1.0E+000 - 3.3E+000)	*		*	*
Cr-51 (40)	9.0E+000 (5.9E+000 - 1.8E+001)	*		*	*
I-131 (40)	1.5E+000 (8.6E-001 - 3.3E+000)	*		*	*
Be-7 (40)	9.4E+000 (3.6E+000 - 2.2E+001)	4.8E+001 (15/36) (1.3E+001 - 2.0E+002)	D04	9.4E+001 (4/4) (4.0E+001 - 2.0E+002)	2.6E+001 (3/4) (2.1E+001 - 3.3E+001)
Ru-103 (40)	1.0E+000 (6.7E-001 - 1.9E+000)	*		*	*
Ba-140 (40)	4.8E+000 (2.8E+000 - 1.0E+001)	*		*	*
Cs-134 (40)	9.5E-001 (5.8E-001 - 2.1E+000)	*		*	*
Ru-106 (40)	9.1E+000 (5.3E+000 - 1.8E+001)	*		*	*
Cs-137 (40)	1.2E+000 (8.4E-001 - 2.7E+000)	5.5E+000 (12/36) (2.3E+000 - 1.2E+001)	D04	8.7E+000 (4/4) (5.1E+000 - 1.2E+001)	1.9E+000 (1/4) (1.9E+000 - 1.9E+000)
Zr-95 (40)	2.0E+000 (1.3E+000 - 4.1E+000)	*		*	*
Nb-95 (40)	1.1E+000 (6.7E-001 - 2.6E+000)	*		*	*
Co-58 (40)	1.0E+000 (6.4E-001 - 2.1E+000)	*		*	*
Mn-54 (40)	1.0E+000 (6.3E-001 - 1.9E+000)	*		*	*

TABLE 3.07B (Cont'd) 90-03-12
Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

Sediment Bq/kg

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Mean (F) (Range)	Reference Station Mean (F) (Range)
Ag-110m (40)	1.3E+000 (7.9E-001 - 2.5E+000)	*		*	*
Ac-228 (40)	4.0E+000 (2.6E+000 - 9.0E+000)	2.1E+001 (36/36) (8.6E+000 - 4.2E+001)	D01	3.4E+001 (4/4) (3.0E+001 - 4.2E+001)	2.8E+001 (4/4) (2.5E+001 - 3.0E+001)
Fe-59 (40)	2.6E+000 (1.8E+000 - 4.8E+000)	*		*	*
Zn-65 (40)	2.7E+000 (1.8E+000 - 4.7E+000)	*		*	*
Co-60 (40)	1.2E+000 (7.6E-001 - 2.5E+000)	*		*	*
K-40 (40)	1.0E+001 (5.7E+000 - 2.0E+001)	5.6E+002 (36/36) (4.4E+002 - 7.3E+002)	D01	6.9E+002 (4/4) (6.2E+002 - 7.3E+002)	4.8E+002 (4/4) (4.2E+002 - 5.3E+002)
La-140 (40)	1.4E+000 (4.6E-001 - 2.6E+000)	*		*	*

* : The activity is less than or equal to the Critical Level (99% Confidence Level).

F : Number of analyses greater than the Critical Level/Total number of analyses.

TABLE 3.08 90-03-12
Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

Well Water Bq/L

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Mean (F) (Range)	Reference Station Mean (F) (Range)
ALPHA (20)	5.4E-002 (1.6E-002 - 1.8E-001)	9.4E-002 (11/18) (3.1E-002 - 1.9E-001)	H04	1.6E-001 (2/2) (1.3E-001 - 1.9E-001)	6.4E-002 (1/2) (6.4E-002 - 6.4E-002)
BETA (20)	4.3E-002 (2.5E-002 - 1.1E-001)	8.4E-002 (13/18) (3.8E-002 - 1.4E-001)	D03	1.2E-001 (2/2) (1.0E-001 - 1.4E-001)	1.2E-001 (2/2) (7.7E-002 - 1.6E-001)
H-3 (20)	1.6E+001 (1.6E+001 - 1.7E+001)	2.4E+001 (8/18) (1.8E+001 - 2.8E+001)	H04	2.8E+001 (1/2) (2.8E+001 - 2.8E+001)	*
Ce-144 (20)	1.3E+000 (9.2E-001 - 2.2E+000)	*		*	*
Ce-141 (20)	3.2E-001 (2.2E-001 - 4.8E-001)	*		*	*
Cr-51 (20)	1.5E+000 (9.7E-001 - 2.2E+000)	*		*	*
I-131 (20)	2.3E-001 (1.5E-001 - 3.3E-001)	*		*	*
Be-7 (20)	1.3E+000 (8.6E-001 - 2.2E+000)	*		*	*
Ru-103 (20)	1.7E-001 (8.7E-002 - 2.3E-001)	*		*	*
Ba-140 (20)	7.2E-001 (4.4E-001 - 9.9E-001)	*		*	*
Cs-134 (20)	1.5E-001 (9.5E-002 - 2.1E-001)	*		*	*
Ru-106 (20)	1.3E+000 (8.2E-001 - 2.2E+000)	*		*	*
Cs-137 (20)	1.5E-001 (9.9E-002 - 2.1E-001)	*		*	*
Zr-95 (20)	2.4E-001 (1.1E-001 - 4.1E-001)	*		*	*

TABLE 3.08 (Cont'd)
Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

90-03-12

Well Water Bq/L

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Mean (F) (Range)	Reference Station Mean (F) (Range)
Nb-95 (20)	1.4E-001 (8.7E-002 - 2.2E-001)	*		*	*
Co-58 (20)	1.4E-001 (8.1E-002 - 2.0E-001)	*		*	*
Mn-54 (20)	1.4E-001 (6.5E-002 - 2.2E-001)	*		*	*
Ag-110m (20)	1.9E-001 (6.4E-002 - 2.8E-001)	*		*	*
Ac-228 (20)	5.8E-001 (4.1E-001 - 8.6E-001)	*		*	*
Fe-59 (20)	3.2E-001 (2.1E-001 - 4.7E-001)	*		*	*
Zn-65 (20)	3.2E-001 (2.0E-001 - 4.1E-001)	*		*	*
Co-60 (20)	1.6E-001 (9.4E-002 - 2.4E-001)	*		*	*
K-40 (20)	2.1E+000 (1.3E+000 - 2.7E+000)	*		*	*
La-140 (20)	2.1E-001 (9.4E-002 - 2.9E-001)	*		*	*

* : The activity is less than or equal to the Critical Level (99% Confidence Level).

F : Number of analyses greater than the Critical Level/Total number of analyses.

TABLE 3.09 90-03-12

Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

Bore Hole Water Bq/L

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Highest Indicator Station Mean (F) (Range)	Reference Station Mean (F) (Range)
H-3 (12)	1.7E+001 (1.6E+001 - 1.8E+001)	9.3E+001 (12/12) (5.0E+001 - 1.9E+002)	1008	1.2E+002 (4/4) (7.5E+001 - 1.9E+002)	*
Ce-144 (12)	1.0E+000 (8.8E-001 - 1.2E+000)	*		*	*
Ce-141 (12)	2.5E-001 (2.1E-001 - 2.9E-001)	*		*	*
Cr-51 (12)	1.2E+000 (9.2E-001 - 1.4E+000)	*		*	*
I-131 (12)	1.9E-001 (1.6E-001 - 2.5E-001)	*		*	*
Be-7 (12)	1.2E+000 (9.3E-001 - 1.5E+000)	*		*	*
Ru-103 (12)	1.4E-001 (1.2E-001 - 1.6E-001)	*		*	*
Ba-140 (12)	6.3E-001 (5.5E-001 - 8.0E-001)	*		*	*
Cs-134 (12)	1.1E-001 (7.9E-002 - 1.6E-001)	*		*	*
Ru-106 (12)	1.1E+000 (8.9E-001 - 1.5E+000)	*		*	*
Cs-137 (12)	1.4E-001 (8.9E-002 - 1.8E-001)	*		*	*
Zr-95 (12)	2.0E-001 (1.2E-001 - 3.3E-001)	*		*	*
Nb-95 (12)	1.3E-001 (7.6E-002 - 1.7E-001)	*		*	*
Co-58 (12)	1.2E-001 (9.2E-002 - 1.6E-001)	*		*	*

TABLE 3.09 (Cont'd) 90-03-12
Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

Bore Hole Water Bq/L

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Mean (F) (Range)	Reference Station Mean (F) (Range)
Mn-54 (12)	1.2E-001 (6.5E-002 - 1.7E-001)	*		*	*
Ag-110m (12)	1.5E-001 (1.1E-001 - 1.8E-001)	*		*	*
Ac-228 (12)	5.2E-001 (3.8E-001 - 6.2E-001)	*		*	*
Fe-59 (12)	2.6E-001 (1.5E-001 - 3.8E-001)	*		*	*
Zn-65 (12)	2.8E-001 (2.0E-001 - 4.0E-001)	*		*	*
Co-60 (12)	1.5E-001 (1.1E-001 - 2.0E-001)	*		*	*
K-40 (12)	1.9E+000 (5.4E-001 - 2.6E+000)	2.9E+000 (1/12) (2.9E+000 - 2.9E+000)	100A	2.9E+000 (1/4) (2.9E+000 - 2.9E+000)	*
La-140 (12)	2.0E-001 (1.4E-001 - 3.1E-001)	*		*	*

* : The activity is less than or equal to the Critical Level (99% Confidence Level).

F : Number of analyses greater than the Critical Level/Total number of analyses.

TABLE 3.10 90-03-12
Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

Parshall Flume Bq/L

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Mean (F) (Range)	Reference Station Mean (F) (Range)
H-3 (51)	1.7E+001 (1.6E+001 - 2.0E+001)	2.2E+002 (51/51) (2.8E+001 - 5.4E+002)	101	2.2E+002 (51/51) (2.8E+001 - 5.4E+002)	*
Ce-144 (51)	9.7E-001 (7.6E-001 - 1.3E+000)	*		*	*
Ce-141 (51)	2.2E-001 (1.8E-001 - 2.7E-001)	*		*	*
Cr-51 (51)	1.1E+000 (8.0E-001 - 1.4E+000)	*		*	*
I-131 (51)	1.5E-001 (9.6E-002 - 2.9E-001)	*		*	*
Be-7 (51)	1.1E+000 (7.6E-001 - 1.4E+000)	*		*	*
Ru-103 (51)	1.3E-001 (9.6E-002 - 1.6E-001)	*		*	*
Ba-140 (51)	5.1E-001 (3.2E-001 - 6.9E-001)	*		*	*
Cs-134 (51)	1.1E-001 (6.2E-002 - 1.5E-001)	*		*	*
Ru-106 (51)	1.1E+000 (5.2E-001 - 1.6E+000)	*		*	*
Cs-137 (51)	1.3E-001 (7.7E-002 - 1.9E-001)	*		*	*
Zr-95 (51)	2.0E-001 (7.7E-002 - 2.8E-001)	*		*	*
Nb-95 (51)	1.1E-001 (6.0E-002 - 1.7E-001)	*		*	*
Co-58 (51)	1.1E-001 (4.5E-002 - 1.6E-001)	*		*	*

TABLE 3.10 (Cont'd) 90-03-12
Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

Parshall Flume Bq/L

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Highest Indicator Station Mean (F) (Range)	Reference Station Mean (F) (Range)
Mn-54 (51)	1.2E-001 (6.4E-002 - 1.6E-001)	*		*	*
Ag-110m (51)	1.5E-001 (6.3E-002 - 2.4E-001)	*		*	*
Ac-228 (51)	4.7E-001 (2.9E-001 - 6.7E-001)	*		*	*
Fe-59 (51)	2.6E-001 (1.0E-001 - 3.4E-001)	*		*	*
Zn-65 (51)	2.7E-001 (1.1E-001 - 3.9E-001)	*		*	*
Co-60 (51)	1.3E-001 (6.6E-002 - 2.0E-001)	*		*	*
K-40 (51)	1.9E+000 (5.4E-001 - 2.7E+000)	2.4E+000 (3/51) (2.3E+000 - 2.7E+000)	101	2.4E+000 (3/51) (2.3E+000 - 2.7E+000)	*
La-140 (51)	1.6E-001 (8.5E-002 - 2.8E-001)	*		*	*

* : The activity is less than or equal to the Critical Level (99% Confidence Level).

F : Number of analyses greater than the Critical Level/Total number of analyses.

TABLE 3.11 90-03-12
Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

Lagoon Water Bq/L

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Highest Indicator Station Mean (F) (Range)	Reference Station Mean (F) (Range)
H-3 (35)	1.7E+001 (1.5E+001 - 2.1E+001)	8.0E+002 (35/35) (3.8E+001 - 3.4E+003)	K03W	1.1E+003 (12/12) (2.7E+002 - 2.6E+003)	*
Gd-153 (35)	7.4E-001 (6.3E-001 - 1.1E+000)	*		*	*
Ce-144 (35)	1.6E+000 (1.2E+000 - 2.1E+000)	*		*	*
Mo-99 (35)	5.4E-001 (3.2E-001 - 1.0E+000)	*		*	*
Ce-141 (35)	4.0E-001 (3.1E-001 - 5.3E-001)	*		*	*
Np-239 (35)	4.4E+000 (2.5E+000 - 9.6E+000)	*		*	*
Cr-51 (35)	2.4E+000 (1.7E+000 - 3.2E+000)	*		*	*
Gd-159 (35)	8.7E+001 (9.7E+000 - 4.8E+002)	*		*	*
I-131 (35)	3.4E-001 (2.5E-001 - 4.6E-001)	*		*	*
Ru-103 (35)	2.7E-001 (1.8E-001 - 3.5E-001)	*		*	*
Ba-140 (35)	1.2E+000 (7.8E-001 - 1.7E+000)	*		*	*
Cs-134 (35)	2.5E-001 (1.7E-001 - 3.7E-001)	*		*	*
Ru-106 (35)	2.3E+000 (1.3E+000 - 3.3E+000)	*		*	*
Cs-137 (35)	2.7E-001 (1.6E-001 - 3.6E-001)	*		*	*

TABLE 3.11 (Cont'd)
Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

90-03-12

Lagoon Water Bq/L

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Mean (F) (Range)	Reference Station Mean (F) (Range)
Zr-95 (35)	4.5E-001 (2.9E-001 - 6.1E-001)	*		*	*
Nb-95 (35)	2.5E-001 (1.3E-001 - 3.5E-001)	*		*	*
Co-58 (35)	2.5E-001 (9.5E-002 - 4.3E-001)	*		*	*
Mn-54 (35)	2.4E-001 (1.4E-001 - 3.8E-001)	*		*	*
Ag-110m (35)	3.5E-001 (1.4E-001 - 5.5E-001)	*		*	*
Sc-46 (35)	2.5E-001 (1.0E-001 - 3.5E-001)	*		*	*
Fe-59 (35)	5.2E-001 (2.3E-001 - 8.3E-001)	*		*	*
Zn-65 (35)	5.8E-001 (3.4E-001 - 8.8E-001)	*		*	*
Co-60 (35)	2.9E-001 (1.4E-001 - 4.3E-001)	*		*	*
La-140 (35)	3.6E-001 (1.9E-001 - 7.6E-001)	*		*	*
Sb-124 (35)	5.6E-001 (3.7E-001 - 1.1E+000)	*		*	*

* : The activity is less than or equal to the Critical Level (99% Confidence Level).

F : Number of analyses greater than the Critical Level/Total number of analyses.

TABLE 3.12
Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

90-03-12

Sea Water Bq/L

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Highest Indicator Station Mean (F) (Range)	Reference Station Mean (F) (Range)
H-3 (18)	1.6E+001 (1.5E+001 - 1.6E+001)	3.9E+001 (5/13) (1.6E+001 - 7.8E+001)	H03	4.5E+001 (4/5) (2.1E+001 - 7.8E+001)	*
Ce-144 (18)	1.0E+000 (8.9E-001 - 1.1E+000)	*		*	*
Ce-141 (18)	2.3E-001 (2.1E-001 - 2.5E-001)	*		*	*
Cr-51 (18)	1.1E+000 (8.8E-001 - 1.3E+000)	*		*	*
I-131 (18)	1.7E-001 (1.3E-001 - 2.2E-001)	*		*	*
Be-7 (18)	1.1E+000 (8.7E-001 - 1.3E+000)	*		*	*
Ru-103 (18)	1.3E-001 (9.0E-002 - 1.6E-001)	*		*	*
Ba-140 (18)	5.1E-001 (3.3E-001 - 6.9E-001)	*		*	*
Cs-134 (18)	1.2E-001 (7.9E-002 - 1.5E-001)	*		*	*
Ru-106 (18)	1.1E+000 (5.2E-001 - 1.4E+000)	*		*	*
Cs-137 (18)	1.4E-001 (8.8E-002 - 1.7E-001)	*		*	*
Zr-95 (18)	2.3E-001 (1.1E-001 - 3.7E-001)	*		*	*
Nb-95 (18)	1.3E-001 (9.6E-002 - 1.7E-001)	*		*	*
Co-58 (18)	1.2E-001 (7.9E-002 - 1.5E-001)	*		*	*

TABLE 3.12 (Cont'd) 90-03-12
Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

Sea Water Bq/L

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Mean (F) (Range)	Reference Station Mean (F) (Range)
Mn-54 (18)	1.1E-001 (6.5E-002 - 1.6E-001)	*		*	*
Ag-110m (18)	1.5E-001 (9.0E-002 - 1.9E-001)	*		*	*
Ac-228 (18)	4.6E-001 (3.4E-001 - 6.9E-001)	*		*	*
Fe-59 (18)	2.8E-001 (1.8E-001 - 3.6E-001)	*		*	*
Zn-65 (18)	3.0E-001 (1.6E-001 - 4.7E-001)	*		*	*
Co-60 (18)	1.5E-001 (6.6E-002 - 2.1E-001)	*		*	*
K-40 (18)	1.4E+000 (0.0E+001 - 2.5E+000)	1.0E+001 (13/13) (7.2E+000 - 1.3E+001)	N05	1.2E+001 (4/4) (1.1E+001 - 1.2E+001)	1.0E+001 (4/5) (3.8E+000 - 1.4E+001)
La-140 (18)	1.7E-001 (8.9E-002 - 2.4E-001)	*		*	*

* : The activity is less than or equal to the Critical Level (99% Confidence Level).

F : Number of analyses greater than the Critical Level/Total number of analyses.

TABLE 3.13 90-03-12

Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

Milk Bq/L

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Highest Indicator Station Mean (F) (Range)	Reference Station Mean (F) (Range)
H-3 (20)	1.6E+001 (1.6E+001 - 1.7E+001)	1.9E+001 (1/8) (1.9E+001 - 1.9E+001)	X10	1.9E+001 (1/4) (1.9E+001 - 1.9E+001)	*
Ce-144 (20)	3.4E-001 (3.3E-001 - 3.5E-001)	*		*	*
Ce-141 (20)	8.0E-002 (7.4E-002 - 8.7E-002)	*		*	*
Cr-51 (20)	4.0E-001 (3.8E-001 - 4.6E-001)	*		*	*
I-131 (20)	5.9E-002 (4.9E-002 - 8.6E-002)	*		*	*
Be-7 (20)	3.9E-001 (3.6E-001 - 4.3E-001)	*		*	*
Ru-103 (20)	4.6E-002 (4.2E-002 - 5.0E-002)	*		*	*
Ba-140 (20)	1.9E-001 (1.7E-001 - 2.6E-001)	*		*	*
Cs-134 (20)	4.2E-002 (3.9E-002 - 4.7E-002)	*		*	*
Ru-106 (20)	4.3E-001 (3.9E-001 - 4.6E-001)	*		*	*
Cs-137 (20)	5.2E-002 (3.8E-002 - 5.8E-002)	1.1E-001 (2/8) (8.6E-002 - 1.2E-001)	A04	1.2E-001 (1/4) (1.2E-001 - 1.2E-001)	7.6E-002 (1/12) (7.6E-002 - 7.6E-002)
Zr-95 (20)	8.2E-002 (7.1E-002 - 9.0E-002)	*		*	*
Nb-95 (20)	4.6E-002 (4.1E-002 - 5.0E-002)	*		*	*
Co-58 (20)	4.7E-002 (4.3E-002 - 5.2E-002)	*		*	*

TABLE 3.13 (Cont'd)
Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

90-03-12

Milk Bq/L

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Mean (F) (Range)	Reference Station Mean (F) (Range)
Mn-54 (20)	4.7E-002 (4.3E-002 - 5.2E-002)	*		*	*
Ag-110m (20)	6.4E-002 (5.8E-002 - 7.1E-002)	*		*	*
Ac-228 (20)	1.8E-001 (1.7E-001 - 2.0E-001)	*		*	*
Fe-59 (20)	1.2E-001 (1.1E-001 - 1.4E-001)	*		*	*
Zn-65 (20)	1.3E-001 (1.2E-001 - 1.4E-001)	*		*	*
Co-60 (20)	5.6E-002 (4.9E-002 - 6.1E-002)	*		*	*
K-40 (20)	5.4E-001 (4.6E-001 - 5.9E-001)	5.4E+001 (8/8) (5.2E+001 - 5.7E+001)	A04	5.4E+001 (4/4) (5.3E+001 - 5.7E+001)	5.2E+001 (12/12) (5.0E+001 - 5.4E+001)
La-140 (20)	5.4E-002 (4.3E-002 - 7.1E-002)	*		*	*

* : The activity is less than or equal to the Critical Level (99% Confidence Level).

F : Number of analyses greater than the Critical Level/Total number of analyses.

TABLE 3.14 90-03-12
Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

Clams, Edible, Raw Mass Bq/kg

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Highest Indicator Station Mean (F) (Range)	Reference Station Mean (F) (Range)
Ce-144 (11)	2.1E+001 (1.6E+001 - 3.0E+001)	*		*	*
Ce-141 (11)	5.0E+000 (3.9E+000 - 6.5E+000)	*		*	*
Cr-51 (11)	3.1E+001 (2.0E+001 - 4.0E+001)	*		*	*
I-131 (11)	3.9E+000 (2.8E+000 - 5.1E+000)	*		*	*
Be-7 (11)	2.9E+001 (1.9E+001 - 3.9E+001)	*		*	*
Ru-103 (11)	3.2E+000 (2.0E+000 - 4.4E+000)	*		*	*
Ba-140 (11)	1.4E+001 (7.0E+000 - 2.0E+001)	*		*	*
Cs-134 (11)	3.5E+000 (2.3E+000 - 4.8E+000)	*		*	*
Ru-106 (11)	2.9E+001 (1.5E+001 - 4.9E+001)	*		*	*
Cs-137 (11)	3.9E+000 (2.9E+000 - 5.1E+000)	*		*	*
Zr-95 (11)	6.0E+000 (4.0E+000 - 7.3E+000)	*		*	*
Nb-95 (11)	3.0E+000 (1.6E+000 - 4.5E+000)	*		*	*
Co-58 (11)	3.2E+000 (2.4E+000 - 4.7E+000)	*		*	*
Mn-54 (11)	3.3E+000 (2.3E+000 - 4.7E+000)	*		*	*

TABLE 3.14 (Cont'd) 90-03-12
Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

Clams, Edible, Raw Mass Bq/kg

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Highest Indicator Station Mean (F) (Range)	Reference Station Mean (F) (Range)
Ag-110m (11)	4.6E+000 (3.2E+000 - 7.6E+000)	*		*	*
Ac-228 (11)	1.5E+001 (8.4E+000 - 2.6E+001)	3.0E+001 (2/10) (2.9E+001 - 3.1E+001)	C01	3.1E+001 (1/4) (3.1E+001 - 3.1E+001)	*
Fe-59 (11)	6.6E+000 (3.1E+000 - 1.0E+001)	*		*	*
Zn-65 (11)	7.0E+000 (4.5E+000 - 9.3E+000)	*		*	*
Co-60 (11)	4.3E+000 (2.9E+000 - 5.6E+000)	*		*	*
K-40 (11)	3.5E+001 (2.0E+001 - 5.6E+001)	1.7E+002 (10/10) (1.2E+002 - 2.0E+002)	B02	1.9E+002 (1/1) (1.9E+002 - 1.9E+002)	2.0E+002 (1/1) (2.0E+002 - 2.0E+002)
La-140 (11)	4.2E+000 (1.9E+000 - 6.0E+000)	*		*	*

* : The activity is less than or equal to the Critical Level (99% Confidence Level).

F : Number of analyses greater than the Critical Level/Total number of analyses.

TABLE 3.15 90-03-12
Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

Crab, Edible, Cooked Mass Bq/kg

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Highest Indicator Station Mean (F) (Range)	Reference Station Mean (F) (Range)
Ce-144 (2)	8.8E+000 (8.5E+000 - 9.0E+000)	*		*	*
Ce-141 (2)	3.4E+000 (3.3E+000 - 3.5E+000)	*		*	*
Cr-51 (2)	2.4E+001 (2.2E+001 - 2.5E+001)	*		*	*
I-131 (2)	9.1E+000 (8.7E+000 - 9.5E+000)	*		*	*
Be-7 (2)	1.6E+001 (1.5E+001 - 1.8E+001)	*		*	*
Ru-103 (2)	1.9E+000 (1.8E+000 - 2.1E+000)	*		*	*
Ba-140 (2)	1.9E+001 (1.8E+001 - 2.0E+001)	*		*	*
Cs-134 (2)	1.6E+000 (1.5E+000 - 1.7E+000)	*		*	*
Ru-106 (2)	1.2E+001 (9.7E+000 - 1.4E+001)	*		*	*
Cs-137 (2)	1.5E+000 (1.4E+000 - 1.6E+000)	*		*	*
Zr-95 (2)	4.3E+000 (3.6E+000 - 5.1E+000)	*		*	*
Nb-95 (2)	1.7E+000 (1.6E+000 - 1.8E+000)	*		*	*
Co-58 (2)	1.6E+000 (1.0E+000 - 2.2E+000)	*		*	*
Mn-54 (2)	1.3E+000 (8.7E-001 - 1.8E+000)	*		*	*

TABLE 3.15 (Cont'd) 90-03-12
Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

Crab, Edible, Cooked Mass Bq/kg

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Highest Indicator Station Mean (F) (Range)	Reference Station Mean (F) (Range)
Ag-110m (2)	2.6E+000 (2.5E+000 - 2.7E+000)	*		*	*
Ac-228 (2)	6.1E+000 (6.0E+000 - 6.2E+000)	*		*	*
Fe-59 (2)	4.0E+000 (3.3E+000 - 4.7E+000)	*		*	*
Zn-65 (2)	4.0E+000 (3.9E+000 - 4.0E+000)	*		*	*
Co-60 (2)	1.9E+000 (1.8E+000 - 2.1E+000)	*		*	*
K-40 (2)	1.2E+001 (1.2E+001 - 1.2E+001)	1.1E+002 (2/2) (1.0E+002 - 1.2E+002)	H02	1.1E+002 (2/2) (1.0E+002 - 1.2E+002)	*
La-140 (2)	4.4E+000 (3.3E+000 - 5.4E+000)	*		*	*

* : The activity is less than or equal to the Critical Level (99% Confidence Level).

F : Number of analyses greater than the Critical Level/Total number of analyses.

TABLE 3.16 90-03-12

Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

Dulse, Wet Mass Bq/kg

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Highest Indicator Station Mean (F) (Range)	Reference Station Mean (F) (Range)
Ce-144 (3)	9.0E+000 (7.7E+000 - 1.1E+001)	*		*	*
Ce-141 (3)	2.0E+000 (1.7E+000 - 2.4E+000)	*		*	*
Cr-51 (3)	1.1E+001 (8.5E+000 - 1.6E+001)	*		*	*
I-131 (3)	1.9E+000 (1.6E+000 - 2.3E+000)	*		*	*
Be-7 (3)	1.4E+001 (1.1E+001 - 1.9E+001)	*		*	*
Ru-103 (3)	1.5E+000 (1.2E+000 - 2.1E+000)	*		*	*
Ba-140 (3)	6.6E+000 (5.3E+000 - 8.7E+000)	*		*	*
Cs-134 (3)	1.3E+000 (9.2E-001 - 1.8E+000)	*		*	*
Ru-106 (3)	1.7E+001 (1.2E+001 - 2.1E+001)	*		*	*
Cs-137 (3)	1.8E+000 (1.3E+000 - 2.8E+000)	*		*	*
Zr-95 (3)	3.0E+000 (2.4E+000 - 3.9E+000)	*		*	*
Nb-95 (3)	1.3E+000 (8.9E-001 - 1.9E+000)	*		*	*
Co-58 (3)	1.6E+000 (1.2E+000 - 2.2E+000)	*		*	*
Mn-54 (3)	1.5E+000 (1.1E+000 - 2.2E+000)	*		*	*

TABLE 3.16 (Cont'd) 90-03-12
Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

Dulse, Wet Mass Bq/kg

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Mean (F) (Range)	Reference Station Mean (F) (Range)
Ag-110m (3)	2.3E+000 (1.7E+000 - 2.9E+000)	*		*	*
Ac-228 (3)	6.7E+000 (6.4E+000 - 7.0E+000)	*		*	*
Fe-59 (3)	3.6E+000 (3.2E+000 - 4.3E+000)	*		*	*
Zn-65 (3)	4.2E+000 (3.6E+000 - 4.8E+000)	*		*	*
Co-60 (3)	2.1E+000 (1.6E+000 - 2.6E+000)	*		*	*
K-40 (3)	1.4E+001 (1.1E+001 - 2.0E+001)	5.3E+002 (3/3) (3.7E+002 - 7.3E+002)	G04	6.0E+002 (2/2) (4.8E+002 - 7.3E+002)	*
La-140 (3)	2.0E+000 (1.2E+000 - 3.0E+000)	*		*	*

* : The activity is less than or equal to the Critical Level (99% Confidence Level).

F : Number of analyses greater than the Critical Level/Total number of analyses.

TABLE 3.17 90-03-12
Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

Fish, Various, Edible,Raw Mass Bq/kg

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Highest Indicator Station Mean (F) (Range)	Reference Station Mean (F) (Range)
Ce-144 (9)	5.7E+000 (1.5E+000 - 1.0E+001)	*		*	*
Ce-141 (9)	1.7E+000 (3.6E-001 - 3.2E+000)	*		*	*
Cr-51 (9)	1.1E+001 (2.7E+000 - 2.0E+001)	*		*	*
I-131 (9)	3.1E+000 (8.4E-001 - 6.7E+000)	*		*	*
Be-7 (9)	9.5E+000 (1.6E+000 - 1.8E+001)	*		*	*
Ru-103 (9)	1.0E+000 (2.1E-001 - 2.2E+000)	*		*	*
Ba-140 (9)	7.1E+000 (1.9E+000 - 1.6E+001)	*		*	*
Cs-134 (9)	8.6E-001 (2.5E-001 - 2.0E+000)	*		*	*
Ru-106 (9)	9.1E+000 (1.9E+000 - 1.6E+001)	*		*	*
Cs-137 (9)	1.1E+000 (2.2E-001 - 1.9E+000)	*		*	*
Zr-95 (9)	1.9E+000 (4.3E-001 - 3.8E+000)	*		*	*
Nb-95 (9)	1.0E+000 (2.0E-001 - 1.7E+000)	*		*	*
Co-58 (9)	1.0E+000 (2.6E-001 - 1.5E+000)	*		*	*
Mn-54 (9)	1.1E+000 (1.4E-001 - 2.0E+000)	*		*	*

TABLE 3.17 (Cont'd) 90-03-12
Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

Fish, Various, Edible,Raw Mass Bq/kg

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Highest Indicator Station Mean (F) (Range)	Reference Station Mean (F) (Range)
Ag-110m (9)	1.4E+000 (3.5E-001 - 2.0E+000)	*		*	*
Ac-228 (9)	3.6E+000 (7.9E-001 - 5.7E+000)	*		*	*
Fe-59 (9)	2.6E+000 (3.4E-001 - 5.6E+000)	*		*	*
Zn-65 (9)	2.6E+000 (6.1E-001 - 5.4E+000)	*		*	*
Co-60 (9)	1.1E+000 (2.4E-001 - 2.6E+000)	*		*	*
K-40 (9)	8.7E+000 (0.0E+001 - 2.4E+001)	1.4E+002 (5/5) (9.4E+001 - 1.8E+002)	G03	1.4E+002 (2/2) (1.4E+002 - 1.4E+002)	1.2E+002 (4/4) (4.7E+001 - 2.2E+002)
La-140 (9)	2.2E+000 (5.8E-001 - 4.7E+000)	*		*	*

* : The activity is less than or equal to the Critical Level (99% Confidence Level).

F : Number of analyses greater than the Critical Level/Total number of analyses.

TABLE 3.18 90-03-12
Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

Lobster, Edible, Cooked Mass Bq/kg

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Mean (F) (Range)	Reference Station Mean (F) (Range)
Ce-144 (7)	8.2E+000 (4.0E+000 - 1.3E+001)	*		*	*
Ce-141 (7)	2.6E+000 (9.9E-001 - 3.9E+000)	*		*	*
Cr-51 (7)	1.9E+001 (5.3E+000 - 3.2E+001)	*		*	*
I-131 (7)	8.6E+000 (8.5E-001 - 1.8E+001)	*		*	*
Be-7 (7)	1.6E+001 (6.6E+000 - 2.9E+001)	*		*	*
Ru-103 (7)	1.9E+000 (7.3E-001 - 3.0E+000)	*		*	*
Ba-140 (7)	1.4E+001 (2.9E+000 - 3.0E+001)	*		*	*
Cs-134 (7)	1.3E+000 (6.9E-001 - 2.5E+000)	*		*	*
Ru-106 (7)	1.2E+001 (7.5E+000 - 2.2E+001)	*		*	*
Cs-137 (7)	1.6E+000 (5.0E-001 - 3.5E+000)	*		*	*
Zr-95 (7)	3.4E+000 (1.4E+000 - 5.1E+000)	*		*	*
Nb-95 (7)	1.9E+000 (9.3E-001 - 3.3E+000)	*		*	*
Co-58 (7)	1.6E+000 (5.2E-001 - 2.8E+000)	*		*	*
Mn-54 (7)	1.4E+000 (7.9E-001 - 3.0E+000)	*		*	*

TABLE 3.18 (Cont'd) 90-03-12
Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

Lobster, Edible, Cooked Mass Bq/kg

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Mean (F) (Range)	Reference Station Mean (F) (Range)
Ag-110m (7)	2.0E+000 (1.0E+000 - 2.8E+000)	*		*	*
Ac-228 (7)	5.8E+000 (2.9E+000 - 1.0E+001)	*		*	*
Fe-59 (7)	4.1E+000 (9.9E-001 - 7.3E+000)	*		*	*
Zn-65 (7)	3.8E+000 (1.9E+000 - 7.2E+000)	*		*	*
Co-60 (7)	1.7E+000 (7.8E-001 - 3.3E+000)	*		*	*
K-40 (7)	1.4E+001 (7.8E+000 - 2.7E+001)	1.1E+002 (6/6) (7.6E+001 - 1.9E+002)	H02	1.1E+002 (6/6) (7.6E+001 - 1.9E+002)	1.0E+002 (1/1) (1.0E+002 - 1.0E+002)
La-140 (7)	4.7E+000 (8.7E-001 - 1.2E+001)	*		*	*

* : The activity is less than or equal to the Critical Level (99% Confidence Level).

F : Number of analyses greater than the Critical Level/Total number of analyses.

TABLE 3.19 90-03-12
Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

Periwinkles, Edible, Raw Mass Bq/kg

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Highest Indicator Station Mean (F) (Range)	Reference Station Mean (F) (Range)
Ce-144 (7)	1.5E+001 (1.1E+001 - 1.9E+001)	*		*	*
Ce-141 (7)	4.8E+000 (2.3E+000 - 7.6E+000)	*		*	*
Cr-51 (7)	2.8E+001 (1.7E+001 - 3.9E+001)	*		*	*
I-131 (7)	1.0E+001 (2.4E+000 - 1.7E+001)	*		*	*
Be-7 (7)	2.5E+001 (1.8E+001 - 3.9E+001)	*		*	*
Ru-103 (7)	3.2E+000 (2.3E+000 - 4.6E+000)	*		*	*
Ba-140 (7)	2.1E+001 (6.4E+000 - 3.5E+001)	*		*	*
Cs-134 (7)	2.6E+000 (1.5E+000 - 3.5E+000)	*		*	*
Ru-106 (7)	2.4E+001 (1.3E+001 - 3.2E+001)	*		*	*
Cs-137 (7)	2.6E+000 (1.6E+000 - 3.7E+000)	*		*	*
Zr-95 (7)	4.6E+000 (3.6E+000 - 7.1E+000)	*		*	*
Nb-95 (7)	3.0E+000 (1.9E+000 - 4.9E+000)	*		*	*
Co-58 (7)	2.8E+000 (2.2E+000 - 3.8E+000)	*		*	*
Mn-54 (7)	2.3E+000 (1.3E+000 - 3.3E+000)	*		*	*

TABLE 3.19 (Cont'd) 90-03-12
Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

Periwinkles, Edible, Raw Mass Bq/kg

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Highest Indicator Station Mean (F) (Range)	Reference Station Mean (F) (Range)
Ag-110m (7)	2.9E+000 (2.0E+000 - 3.8E+000)	*		*	*
Ac-228 (7)	9.4E+000 (5.5E+000 - 1.2E+001)	*		*	*
Fe-59 (7)	6.2E+000 (2.4E+000 - 9.8E+000)	*		*	*
Zn-65 (7)	5.4E+000 (2.6E+000 - 9.3E+000)	*		*	*
Co-60 (7)	3.0E+000 (1.7E+000 - 4.7E+000)	*		*	*
K-40 (7)	2.5E+001 (1.5E+001 - 5.5E+001)	1.3E+002 (4/5) (1.1E+002 - 1.8E+002)	N06	1.3E+002 (4/5) (1.1E+002 - 1.8E+002)	1.3E+002 (2/2) (1.2E+002 - 1.3E+002)
La-140 (7)	6.0E+000 (1.5E+000 - 1.3E+001)	*		*	*

* : The activity is less than or equal to the Critical Level (99% Confidence Level).

F : Number of analyses greater than the Critical Level/Total number of analyses.

TABLE 3.20
Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

90-03-12

Scallops, Edible, Raw Mass Bq/kg

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Highest Indicator Station Mean (F) (Range)	Reference Station Mean (F) (Range)
Ce-144 (6)	3.9E+000 (2.9E+000 - 4.7E+000)	*		*	*
Ce-141 (6)	1.4E+000 (8.5E-001 - 2.1E+000)	*		*	*
Cr-51 (6)	8.7E+000 (4.2E+000 - 1.4E+001)	*		*	*
I-131 (6)	4.2E+000 (1.1E+000 - 1.3E+001)	*		*	*
Be-7 (6)	7.6E+000 (4.4E+000 - 1.1E+001)	*		*	*
Ru-103 (6)	7.9E-001 (4.8E-001 - 1.1E+000)	*		*	*
Ba-140 (6)	7.3E+000 (2.9E+000 - 1.4E+001)	*		*	*
Cs-134 (6)	7.1E-001 (5.1E-001 - 9.6E-001)	*		*	*
Ru-106 (6)	6.3E+000 (2.9E+000 - 9.8E+000)	*		*	*
Cs-137 (6)	8.4E-001 (6.3E-001 - 1.1E+000)	*		*	*
Zr-95 (6)	1.4E+000 (5.5E-001 - 2.1E+000)	*		*	*
Nb-95 (6)	8.4E-001 (6.1E-001 - 1.1E+000)	*		*	*
Co-58 (6)	7.7E-001 (4.7E-001 - 1.3E+000)	*		*	*
Mn-54 (6)	7.4E-001 (5.4E-001 - 9.4E-001)	*		*	*

TABLE 3.20 (Cont'd) 90-03-12
Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

Scallops, Edible, Raw Mass Bq/kg

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Highest Indicator Station Mean (F) (Range)	Reference Station Mean (F) (Range)
Ag-110m (6)	1.0E+000 (8.0E-001 - 1.3E+000)	*		*	*
Ac-228 (6)	2.5E+000 (1.6E+000 - 3.4E+000)	*		*	*
Fe-59 (6)	2.1E+000 (1.4E+000 - 3.1E+000)	*		*	*
Zn-65 (6)	1.9E+000 (1.2E+000 - 2.4E+000)	*		*	*
Co-60 (6)	9.7E-001 (6.3E-001 - 1.4E+000)	*		*	*
K-40 (6)	7.7E+000 (3.9E+000 - 1.1E+001)	1.2E+002 (5/5) (1.0E+002 - 1.5E+002)	H02	1.5E+002 (1/1) (1.5E+002 - 1.5E+002)	1.2E+002 (1/1) (1.2E+002 - 1.2E+002)
La-140 (6)	1.7E+000 (6.3E-001 - 3.3E+000)	*		*	*

* : The activity is less than or equal to the Critical Level (99% Confidence Level).

F : Number of analyses greater than the Critical Level/Total number of analyses.

TABLE 3.21 90-03-12
Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

Sea Plant, Wet Mass Bq/kg

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Highest Indicator Station Mean (F) (Range)	Reference Station Mean (F) (Range)
Ce-144 (10)	3.5E+000 (2.7E+000 - 4.0E+000)	*		*	*
Ce-141 (10)	8.1E-001 (6.8E-001 - 1.1E+000)	*		*	*
Cr-51 (10)	4.6E+000 (3.5E+000 - 6.3E+000)	*		*	*
I-131 (10)	6.5E-001 (5.3E-001 - 9.3E-001)	*		*	*
Be-7 (10)	5.5E+000 (3.8E+000 - 7.4E+000)	*		*	*
Ru-103 (10)	5.1E-001 (3.5E-001 - 7.1E-001)	*		*	*
Ba-140 (10)	2.1E+000 (1.5E+000 - 3.3E+000)	*		*	*
Cs-134 (10)	4.9E-001 (3.6E-001 - 6.8E-001)	*		*	*
Ru-106 (10)	5.2E+000 (3.5E+000 - 8.1E+000)	*		*	*
Cs-137 (10)	6.1E-001 (4.1E-001 - 8.0E-001)	*		*	*
Zr-95 (10)	9.0E-001 (6.4E-001 - 1.2E+000)	*		*	*
Nb-95 (10)	5.6E-001 (4.2E-001 - 9.0E-001)	*		*	*
Co-58 (10)	5.3E-001 (3.7E-001 - 7.5E-001)	*		*	*
Mn-54 (10)	5.4E-001 (3.9E-001 - 7.5E-001)	*		*	*

TABLE 3.21 (Cont'd)
Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

Sea Plant, Wet Mass Bq/kg

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Highest Indicator Station Mean (F) (Range)	Reference Station Mean (F) (Range)
Ag-110m (10)	7.5E-001 (6.5E-001 - 7.8E-001)	*		*	*
Ac-228 (10)	2.4E+000 (1.8E+000 - 3.3E+000)	*		*	*
Fe-59 (10)	1.4E+000 (1.0E+000 - 1.8E+000)	*		*	*
Zn-65 (10)	1.6E+000 (1.2E+000 - 2.0E+000)	*		*	*
Co-60 (10)	6.5E-001 (3.5E-001 - 1.2E+000)	*		*	*
K-40 (10)	5.0E+000 (2.7E+000 - 7.1E+000)	2.3E+002 (10/10) (1.8E+002 - 3.2E+002)	H03	2.5E+002 (3/3) (1.8E+002 - 3.2E+002)	*
La-140 (10)	5.7E-001 (2.6E-001 - 8.4E-001)	*		*	*

* : The activity is less than or equal to the Critical Level (99% Confidence Level).

F : Number of analyses greater than the Critical Level/Total number of analyses.

TABLE 3.22 90-03-12
Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

Vegetation Bq/kg

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Highest Indicator Station Mean (F) (Range)	Reference Station Mean (F) (Range)
Ce-144 (14)	3.4E+001 (1.9E+001 - 4.9E+001)	*		*	*
Ce-141 (14)	8.6E+000 (4.6E+000 - 1.2E+001)	*		*	*
Cr-51 (14)	5.4E+001 (3.2E+001 - 7.2E+001)	*		*	*
I-131 (14)	7.4E+000 (3.5E+000 - 1.1E+001)	*		*	*
Be-7 (14)	5.4E+001 (2.8E+001 - 7.2E+001)	2.6E+002 (8/8) (7.0E+001 - 4.6E+002)	I11	4.1E+002 (3/3) (3.3E+002 - 4.6E+002)	1.9E+002 (6/6) (1.2E+002 - 2.7E+002)
Ru-103 (14)	6.1E+000 (2.2E+000 - 9.4E+000)	*		*	*
Ba-140 (14)	2.5E+001 (1.3E+001 - 3.6E+001)	*		*	*
Cs-134 (14)	6.8E+000 (3.2E+000 - 1.1E+001)	*		*	*
Ru-106 (14)	5.6E+001 (3.1E+001 - 7.7E+001)	*		*	*
Cs-137 (14)	7.2E+000 (2.6E+000 - 1.7E+001)	3.0E+001 (7/8) (2.1E+001 - 3.8E+001)	H05	3.2E+001 (3/3) (2.1E+001 - 3.8E+001)	3.4E+001 (6/6) (1.5E+001 - 6.7E+001)
Zr-95 (14)	9.8E+000 (5.0E+000 - 1.5E+001)	*		*	*
Nb-95 (14)	5.4E+000 (2.3E+000 - 8.8E+000)	*		*	*
Co-58 (14)	5.3E+000 (2.2E+000 - 8.7E+000)	*		*	*
Mn-54 (14)	5.2E+000 (2.4E+000 - 9.2E+000)	*		*	*

TABLE 3.22 (Cont'd) 90-03-12
Point Lepreau Generating Station
Environmental Radiation Monitoring
Summary of Analyses for the Period
89-01-01 to 89-12-31

Vegetation Bq/kg

Analysis Type (Total Number)	Critical Level Mean (F) (Range)	Indicator Stations Mean (F) (Range)	Highest Indicator Station Location	Highest Indicator Station Mean (F) (Range)	Reference Station Mean (F) (Range)
Ag-110m (14)	8.0E+000 (4.7E+000 - 1.3E+001)	*		*	*
Ac-228 (14)	2.2E+001 (8.3E+000 - 3.6E+001)	*		*	*
Fe-59 (14)	1.4E+001 (5.0E+000 - 2.0E+001)	*		*	*
Zn-65 (14)	1.2E+001 (4.4E+000 - 1.8E+001)	*		*	*
Co-60 (14)	6.5E+000 (2.5E+000 - 9.6E+000)	*		*	*
K-40 (14)	7.6E+001 (3.2E+001 - 1.9E+002)	2.1E+002 (5/8) (1.6E+002 - 2.5E+002)	K01	2.5E+002 (1/1) (2.5E+002 - 2.5E+002)	2.1E+002 (5/6) (1.5E+002 - 3.4E+002)
La-140 (14)	6.9E+000 (3.1E+000 - 1.3E+001)	*		*	*

* : The activity is less than or equal to the Critical Level (99% Confidence Level).

F : Number of analyses greater than the Critical Level/Total number of analyses.

4.0 DISCUSSION OF ENVIRONMENTAL DATA

4.1 Airborne Particulates (filters) - Table 3.01

There were no detectable airborne particulate radionuclides that could be attributed to the operation of PLGS in 1989.

Gross alpha and gross beta measurements indicate those levels of naturally occurring radionuclides in the environment, cosmogenic radionuclides (Be-7) and any contribution from man-made sources. Plots of the gross alpha and gross beta data from 1976 to 1989 at Dipper Harbour, about 4 km from the PLGS stack in the predominant downwind direction, are presented in Figure 4.1. The baseline data show the naturally occurring levels of radioactivity in the area. The peaks on the plots correspond to fallout from various bomb tests before 1978; from the Chinese bomb test in October of 1980 (fallout occurred in 1981 in N.B.); and from the Chernobyl accident in April 1986.

4.2 Airborne Radioiodines - Table 3.02

All I-131 levels were below the Lower Limit of Detection in 1989.

4.3 Airborne Tritium - Tables 3.03A, 3.03B and 3.03C

Table 3.03A is the summary table of 1989 tritium data; Table 3.03B gives details of 1989 tritium results by location and Table 3.03C is a summary of tritium data obtained since this program was started in 1976.

Tritium was detected in most air monitoring stations on the Point Lepreau peninsula (69 of 84 samples) in 1989. This was the first year that tritium was not detected in any sample at the Reference location. Calculation of the annual average dispersion factor for stack emissions for this and previous years, based upon the data for tritium, indicate good comparison with the graph value at 1 km (2.2E-7 s/m^3) used in the DEL licensing document (1). Results since 1984, the earliest that these calculations could be made, are presented in Tables 4.01 and 4.02.

(1) "Derived Emission Limits for Radionuclides in Gaseous and Liquid Effluents." New Brunswick Electric Power Commission Report NBEPC-HP-76-1, 1976.

TABLE 4.01

AVERAGE ATMOSPHERIC DISPERSION FACTOR
FOR EACH AIR MONITORING LOCATION (1)

Locn.	E01 Maces Bay	F01 Welch Cove	G02 Light-house	H04 Info. Centre	I01 SRWMF	K02 Pump-house	L04 Stores	N01 Dipper Hrbr.
km from stack	4.5	1.5	1.0	0.8	1.0	0.2	0.6	3.8
Year	Dispersion Factors: s/m^3							
1984	8E-8	8E-8	2E-7	5E-7	7E-7*	5E-7		8E-8
1985	2E-8	4E-8	9E-8	3E-7	2E-7	3E-7		5E-8
1986	3E-8	5E-8	1E-7	3E-7	2E-7	5E-7		6E-8
1987	4E-8	5E-8	2E-7	5E-7	4E-7	7E-7		2E-7
1988	3E-8	7E-8	1E-7	4E-7	3E-7	#	2E-7	9E-8
1989	2E-8	4E-8	8E-8	4E-7	3E-7	#	2E-7	8E-8

(1) Excluding the Reference location A01R.

* This value includes a second source term i.e., contaminated containers temporarily located in this facility in 1984, and is ignored in the calculation of the normalised mean dispersion factor. In the calculation of the means at each location, all of the 'less than' data were taken as equal to the 'less than' value.

no longer in use. This monitoring station was relocated to L04 - the Construction Stores Warehouse - in the spring of 1988.

Table 4.02

Normalised Mean Dispersion Factor at 1 km For All Locations

Year	s/m^3
1984	2E-07
1985	1E-07
1986	1E-07
1987	3E-07
1988	2E-07
1989	2E-07
Average over 6 years	2E-07

To derive a normalised mean dispersion factor at 1 km from the stack, for all locations, each dispersion factor value is corrected to 1 km. This is accomplished by tracing back between dispersion curves on the graph of 'Weighted Mean Dilution Factor versus Distance from the Point of Continuous Emission' (reproduced in the DEL licensing document referred to previously).

4.4 Airborne Carbon-14 - Tables 3.04A and 3.04B

Carbon-14 collection and analysis was started in 1983. Results for 1989 are summarized in Table 3.04A. Individual analyses are given in Table 3.04B. All analyses are close to the critical level of detection.

4.5 Environmental Gamma Radiation

4.5.1 TLD data - Tables 3.05A and 3.05B

Background radiation levels on the Lepreau Peninsula during 1989, as measured by TLD (including cosmic radiation and a fraction of the radiation from radon and radon daughters) are comparable with those measured before 1982.
Increasing average values close to the SRWMF might be expected as the facility is filled. Although an upward trend is evident up to 1988, falling off again in 1989, the values are still within the anticipated range of year to year natural background variation considering the values seen before the facility came into use. Average values and ranges are shown below.

TABLE 4.03

AVERAGE BACKGROUND RADIATION (microgray/year)

Year	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	724	841	733	701	838	766	730	829	815	811	880	838
2			845	935	940	941	942	1072	1032	1028	1112	1050
Range at SRWMF:												
low:			750	780	850	880	910	1030	940	990	1080	1020
high:			960	1070	1010	980	1000	1110	1090	1080	1150	1100

1. Average of 17 locations around the Point Lepreau Peninsula. Variation in natural background radiation at any individual location covers a range of about 300 microgray from year to year.
2. Average of 12 locations at the boundary of the Solid

Radioactive Waste Management Facility (within the exclusion zone).

4.5.2 Gamma Survey Measurements Table 3.06

Environmental gamma survey measurements are made in the inter-tidal zone on beaches in the Point Lepreau area and at the Reference location Q01R, 28 km to the ENE. Although TLDs are preferred in measuring such exposures since they span the entire year and provide integrated measurements, they are not suitable for use in these locations.
Radiation levels in 1989 are consistent with those measured prior to 1982.

4.6 Sediments - Tables 3.07A and 3.07B

Sediments collected from beaches and tidal mud flats contain radioactivity, both from naturally occurring radionuclides (K-40) and from the diminishing levels of Cs-137 fallout from bomb tests since the 1950s. A small additional Cs-137 component from Chernobyl was added to this reservoir in 1986.
Both Ac-228, a radioactive daughter of naturally occurring Th-232, and Be-7 - of cosmogenic origin - commonly occur in sediments.
A summary of the Cs-137 levels in sediments over the last twelve years is given in Table 3.07A.

4.7 Soil

No soil samples were analyzed in 1989.

4.8 Well Water - Table 3.08

No gamma emitting radionuclides other than those occurring in nature from radon daughters, were detected in water samples during this sampling period or at any time since measurements were started. Tritium occurred in eight of eighteen well waters (average 24 Bq/L, covering the range from 18 to 28 Bq/L), at just above the Critical Level (about 16 Bq/L). The tritium measurements were made after distillation to avoid interference from radon daughters. The tritium indicates probable surface runoff contribution to some of the wells. The 1987 Guidelines for Canadian Drinking Water Quality recommend 40 000 Bq/L as the maximum acceptable concentration for tritium in drinking water, i.e., tritium in these well waters is typically two thousand times less than that stated in the guidelines. Measurements of gross alpha and beta in well waters are made about 2 weeks after

sample collection in order to minimize interference from natural radon and radon daughters which tend to occur at high concentrations in many New Brunswick well waters, but are outside of the scope of the drinking water guidelines.

4.9 Bore Hole Water (SRWMF) - Table 3.09

Waters from Bore Holes on the SRWMF site were analyzed for radionuclides. Tritium, as tritiated water, was detected in all 12 samples at an average concentration of 93 Bq/L, ranging from 50 to 190 Bq/L. The SRWMF is located on high ground which receives no water flow. All near-surface groundwater in the area is from precipitation which may contain up to this concentration of tritium. No other radionuclides attributable to the operation of PLGS were detected.

4.10 Parshall Flume (SRWMF)-Table 3.10

Rainwater, draining from the SRWMF in a specially constructed drainage channel (flume), is collected and analyzed on a weekly basis. There is little or no flow into or out of this collection location during the winter months and values for tritium, the only detected radionuclide from PLGS, tend to vary little from one week to the next except through dilution after heavy precipitation.
Tritium was detected in all of the 51 Parshall Flume water analyses, ranging from 28 to 540 Bq/L, with a mean value of 220 Bq/L. This is probably due to washout of atmospheric tritium in rainfall and snow at this location. No gamma emitting radionuclides, except for those that occur naturally, were detected in any of the samples.

4.11 Lagoon Water - Table 3.11

Most of the inactive drainage liquid waste from PLGS empties into drainage lagoons on the site. Tritium was detected in all 35 lagoon water samples analyzed, ranging from 38 to 3 400 Bq/L with an average of 800 Bq/L. With a discharge rate of about 1E+2 m^3/day, contributions to the environment in this pathway are about four orders of magnitude less than emissions in the liquid effluent pathway and are thus relatively insignificant. The liquids from these lagoons are drained to the Condenser Cooling Water duct, hence the pathway to the environment is the same as for other liquid effluents.

4.12 Sea Water - Table 3.12

Naturally occurring daughters of radon, and K-40 were the only gamma emitting radionuclides found in sea water during the sampling period. Tritium was detected in 5 of 13 samples at between 16 and 78 Bq/L, with an average of 39 Bq/L. The critical level for the detection of tritium in sea water averages about 16 Bq/L.
Calculations show that the long term average concentration of tritium in sea water due to releases from PLGS in the liquid effluent pathway in 1989, was about 20 Bq/L beyond the outfall. This calculation takes into account the total tritium released over the year, the flow rate of the condenser cooling water (24 m^3/s) and tidal mixing. Because releases are not continuous however, the concentrations of tritium released in the cooling water flow at the time of liquid effluent pump-out may reach several hundred Bq/L at the outfall discharge. Depending upon the time of collection of sea water samples relative to the pumpout time, tritium may occasionally be detectable for a short time at sample collection locations close to the station until dilution occurs through tidal mixing.

4.13 Milk - Table 3.13

Milk from a commercial dairy and milk samples from herds in the south of the province are analyzed on a regular basis as available. There are no commercial herds producing milk in the Point Lepreau area. The closest herds to PLGS are in St. Andrews and Fredericton Junction, and the milks from these locations are analyzed. Cesium-137 from bomb tests in the 1950s through to as recent as 1980, with an additional small contribution from the accident at Chernobyl in 1986, was detected in three of twenty samples. Natural radionuclides (including K-40, at about 50 Bq/L and daughters of uranium and thorium) also occur. A sample from a dairy herd contained 19 Bq of tritium/L of milk, marginally above the critical level of detection of 16 Bq/L. Similar isolated values have been seen in previous years; some, before Point Lepreau became operational. As airborne emissions from PLGS are monitored continuously and were insignificant all year, neither tritium nor gamma emitting radionuclides attributable to the operation of PLGS would be expected to be detected in these milks. The detected value may represent a false positive value as it lies so close to the critical level. Low detection limits for gamma analysis are achieved by long counting intervals (50 000 s) on large volume samples (3.6 L).

4.14 Seafood - Tables 3.14 to 3.20

All of the seafoods analyzed in the environmental program contain

naturally occurring radionuclides e.g., K-40. Some, such as clams and scallops may contain detectable quantities of natural Ac-228. No contributions from the operation of Point Lepreau were detected even though several of the samples (consisting of crabs, scallops and lobster) were collected at the cooling water outflow from PLGS. Dulse, an edible seaweed, is included in this category as it comprises a popular delicacy and snack food in this region.
The inshore fishery suffers some disruption each year due to restrictions placed upon the harvesting of shellfish either for conservation of stocks or because of bacterial contamination, algal-blooms or other natural cycles and these in turn may affect the availability of samples for analysis.

4.15 Sea Plants - Table 3.21

Seaweeds other than dulse are also analyzed. Various species of seaweed, (for example, Ascophylum) are readily available from the rocks on the Point Lepreau peninsula close to the outfall and are collected from time to time. All contain detected natural radioactivity (K-40).

4.16 Vegetation (Lichen) - Table 3.22

Different species of lichen and moss concentrate a wide range of radionuclides, both natural (Be-7) and man-made, and are sensitive indicators of radionuclides in the environment. Cesium-137 is still detected from previous bomb tests. There was no detectable contribution from the operation of PLGS.
Although there is no consistent means of correlating atmospheric concentration and uptake into the lichen or moss, these plants are rapid indicators of the presence of airborne radionuclides and possibly also of various other airborne pollutants in the environment.

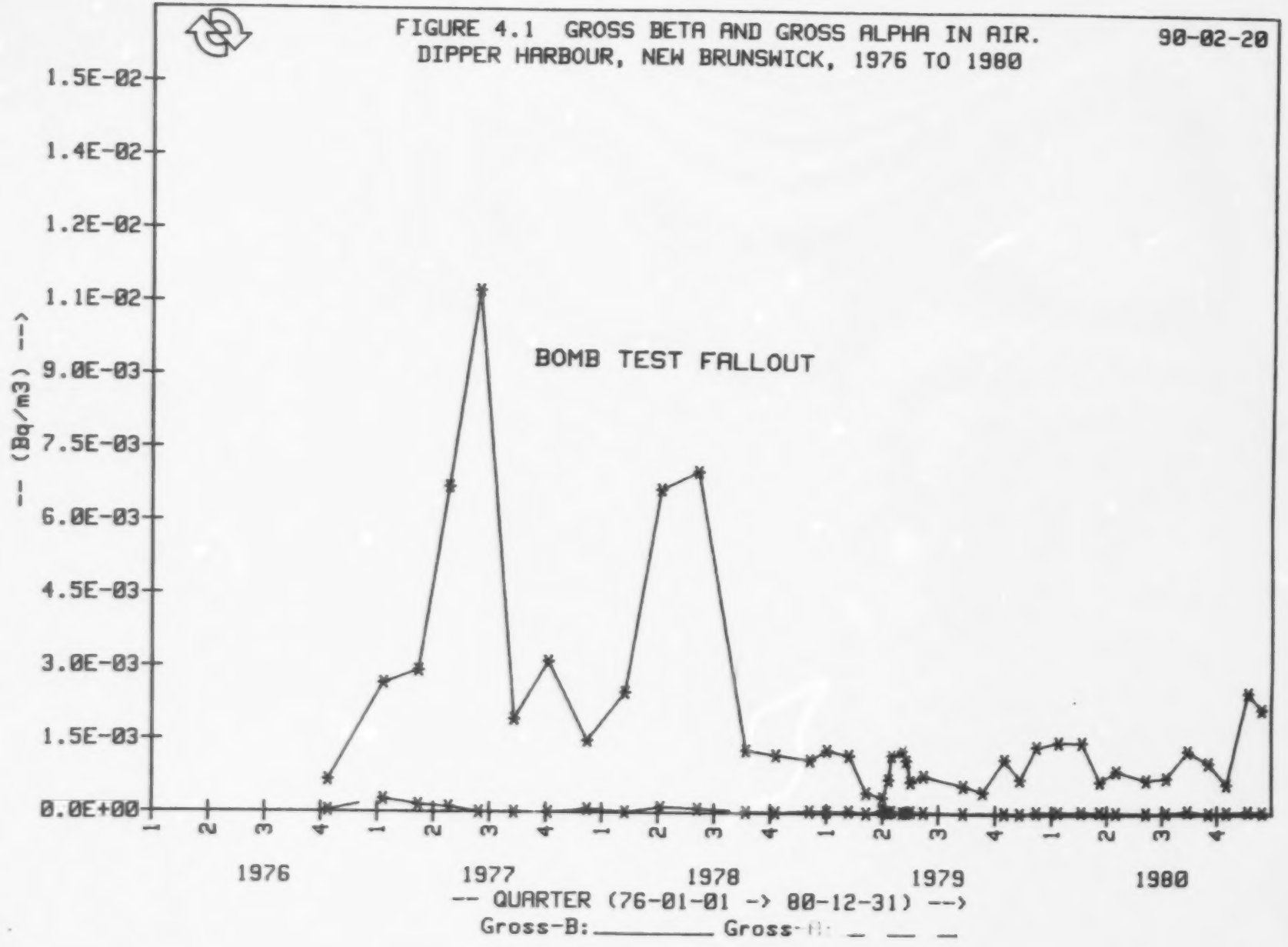


FIGURE 4.1 GROSS BETA AND GROSS ALPHA IN AIR.
DIPPER HARBOUR, NEW BRUNSWICK, 1976 TO 1980
90-02-20
1.5E-02
1.4E-02
1.2E-02
1.1E-02
9.0E-03
7.5E-03
6.0E-03
4.5E-03
3.0E-03
1.5E-03
0.0E+00
-- (Bq/m3) -->
BOMB TEST FALLOUT
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
1976
1977
1978
1979
1980
-- QUARTER (76-01-01 -> 80-12-31) -->
Gross-B:
Gross-A:

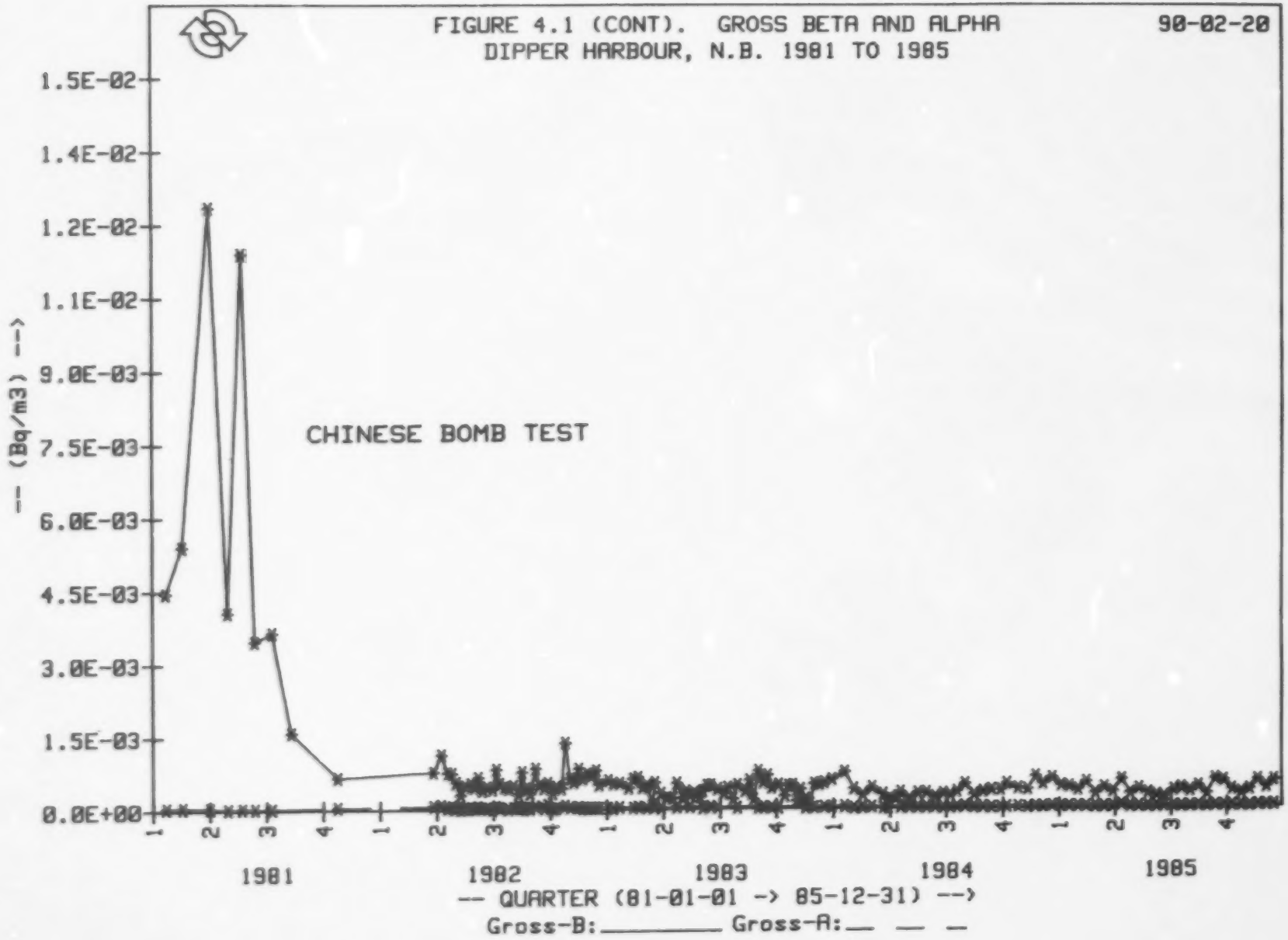


FIGURE 4.1 (CONT). GROSS BETA AND ALPHA
DIPPER HARBOUR, N.B. 1981 TO 1985
90-02-20
1.5E-02
1.4E-02
1.2E-02
1.1E-02
9.0E-03
7.5E-03
6.0E-03
4.5E-03
3.0E-03
1.5E-03
0.0E+00
-- (Bq/m3) -->
CHINESE BOMB TEST
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
1981
1982
1983
1984
1985
-- QUARTER (81-01-01 -> 85-12-31) -->
Gross-B:_____ Gross-A:__ __ __

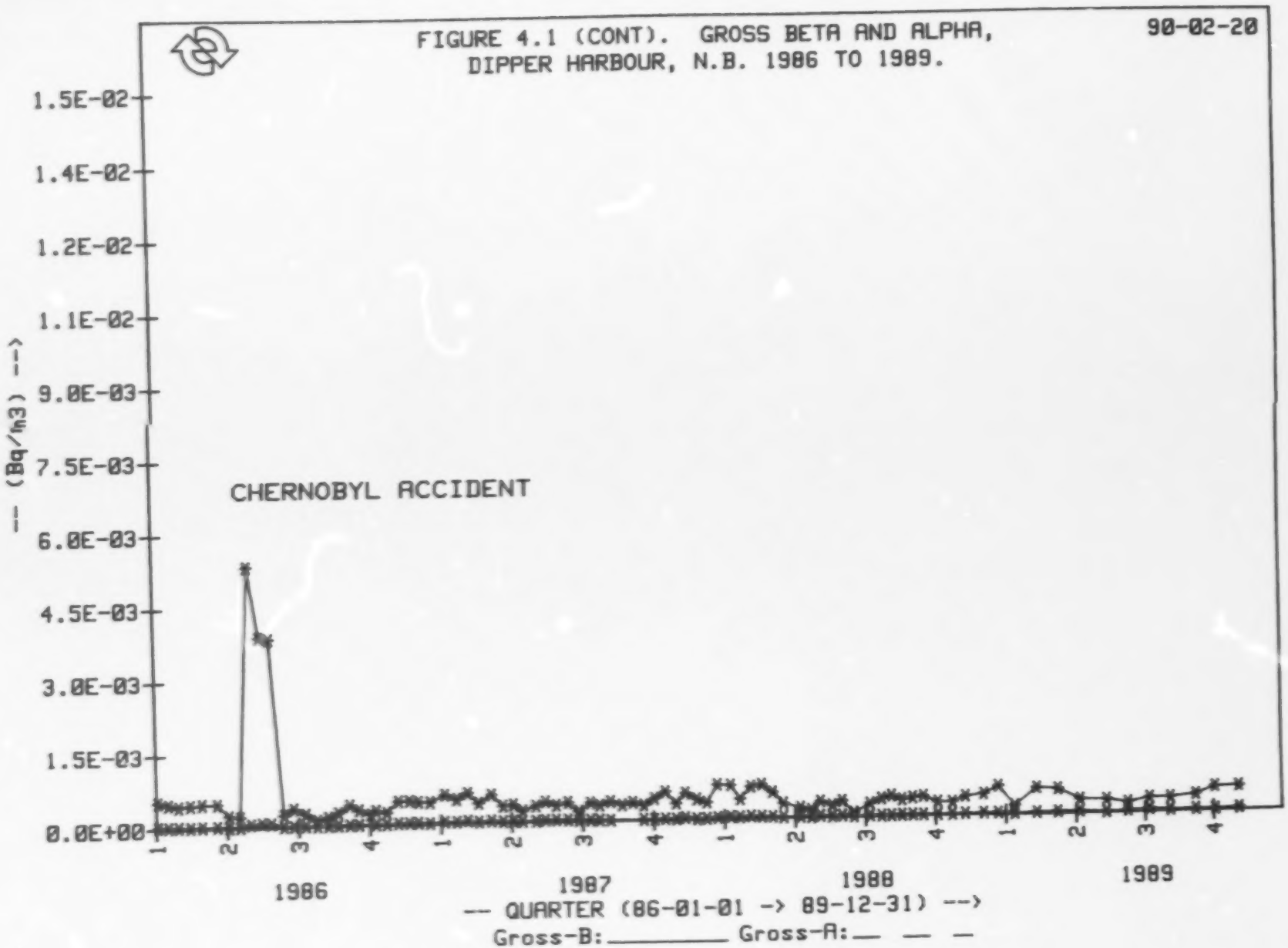


FIGURE 4.1 (CONT). GROSS BETA AND ALPHA,
DIPPER HARBOUR, N.B. 1986 TO 1989.
90-02-20
1.5E-02
1.4E-02
1.2E-02
1.1E-02
9.0E-03
7.5E-03
6.0E-03
4.5E-03
3.0E-03
1.5E-03
0.0E+00
-- (Bq/m3) -->
CHERNOBYL ACCIDENT
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
1986
1987
1988
1989
-- QUARTER (86-01-01 -> 89-12-31) -->
Gross-B:_____ Gross-A:__ __ __

5.0 QUALITY CONTROL AND QUALITY ASSURANCE

5.1 Introduction

Internal Quality Control checks and performance of calibrations traceable to U.S. or Canadian National Standards are routine for all analytical techniques in the Health Physics Environmental Laboratory. In addition, Quality Assurance programs regularly test the accuracy of the laboratory analytical procedures by submitting a variety of samples for blind analysis.

5.2 Quality Control

The daily Quality Control (QC) evaluations in the laboratory cover the following instruments:

1. Intrinsic Ge Gamma Spectrometer
2. Beckman LS-100C Liquid Scintillation Counter
3. Tennelec LB-5100 Gross Alpha/Beta Detector
4. Panasonic UD-710A TLD Reader

In the QC program, the operating parameters of each of the major instruments are evaluated at the start of each working day. This ensures that they are consistent from day to day and remain free from significant drift or random variation that could influence the analyses. A compilation of the statistical fluctuations is maintained day by day to show the upper and lower limits usually seen over the year and from one year to the next. From these data, upper and lower flag limits are set in the QC programs. If any of the equipment exceeds these limits, then it is usually not used in the laboratory operations until the problem has been resolved.

5.2.1 Intrinsic Ge Gamma Spectrometer

A daily check of seven system parameters is performed for the germanium gamma spectrometry system. The results are processed by a computer program which generates QC plots and performs statistical tests to detect out-of-range values. The program processes the results from the analysis of a Eu-152 point source which is analyzed at the beginning of each working day.
A 200 000 s background count (over the weekend) is made weekly to ensure the absence of contamination in the sample chamber. The total counts in eight separate regions of the background spectrum are evaluated by the QC program and out-of-range values are flagged. Because of the precautions adopted in handling all samples analyzed in the laboratory, no contamination has been found to date.

Calibration

Complete efficiency calibrations on the gamma spectrometry systems are performed on an annual basis, usually at the beginning of each year, for each of the counting geometries. This is accomplished by use of an Amersham mixed nuclide standard traceable to the U.S. National Bureau of Standards.

5.2.2 Beckman Liquid Scintillation Counter

A range of sealed tritium, C-14 and background standards traceable to U.S. National Standards is analyzed daily.

5.2.3 Tennelec LB-5100 Gross Alpha/Beta Detector

Planchet standards of Am-241 and Sr-Y-90 are analyzed daily. Alpha and Beta discrimination allows the simultaneous analysis of alpha and beta emissions on all samples analyzed. Planchet and filter backgrounds are included in the QC checks.

5.2.4 Panasonic UD-710A TLD Reader

A set of 16, randomly chosen, TLDs is exposed daily on a depleted uranium slab for about 30 minutes. Readout of these TLDs monitors the Reader functions.

5.3 External Intercomparison Programs

In addition to these in-house QC checks, the Health Physics Environmental Laboratory participates in intercomparisons with other laboratories when appropriate programs are available. This allows independent verification of analytical performance. Table 5.01 lists the intercomparison programs in which NBEPC takes part.

TABLE 5.01

QUALITY ASSURANCE PROGRAMS INVOLVING OTHER AGENCIES

Sample Type	Analysis	Frequency	Agency
Air Filters	Gross Alpha	6 months	US EPA*
	Gross Beta		
	Cs-137		
	Sr-90		
Environmental Gamma rad.	TLD	Approx. every 2 years	US DOE*
Milk	Gamma	6 Months	US EPA
Fresh Water	Gross Alpha	4 months	US EPA
	Gross Beta	4 months	
	Tritium	4 months	
	Gamma	4 months	
	Sr-89,90	4 months	
	I-131	6 months	
Laboratory performance evaluation	Gross Alpha	6 months	US EPA
	Gross Beta	6 months	
	Gamma	6 months	
	Sr-89,90	6 months	

* EPA U.S. Environmental Protection Agency.
DOE U.S. Department of Energy.

5.4 Results of Intercomparison programs

Details of performance in the laboratory intercomparisons are given in Tables 5.02 to 5.09 following. The order of the QA data is as follows:

Table 5.02	Comparison of EPA - All users and NBEPC Performance.
5.03	Laboratory Performance Evaluation.
5.04	EPA Air Filter analyses.
5.05	EPA Gross alpha/beta in Water.
5.06	EPA Gamma in Water.
5.07	EPA strontium 89, -90 in water.
5.08	EPA Radionuclides in Milk.
5.09	EPA tritium in water.

Each table (except Table 5.02), contains the known results given by the QA agent, the average obtained by all participants, and the results obtained by the Health Physics Environmental Monitoring Laboratory of NBEPC. The quoted uncertainties are at the 95% confidence level unless indicated otherwise.

5.5 Discussion of QA results

The QA results for 1989 show that the NB Power environmental monitoring laboratory provided accurate and precise information on the test samples, well within the statistical requirements of the testing program.

Note that the units used in the reporting of the EPA QA results are in picocuries and not becquerels. One becquerel (Bq) is 27 picocuries (pCi).

The criterion for acceptable performance in the EPA tests is that the participant's results shall be within 3 standard deviations of the known value. However, analyses which are consistently at this limit, whether high or low, indicate that improvements should be attempted.

TABLE 5.02 90-03-12

Point Lepreau Generating Station
Environmental Radiation Monitoring
Quality Assurance Program
89-01-01 to 89-12-31

Comparison of EPA, All Participants and NBEPC

Analysis	Table No.	Sample Date	Ratio of Results NBEPC/EPA	+- 2 sigma range * All Participants
BETA	5.03	89-04-18	1.01	0.6 - 1.1
	5.03	89-10-31	1.02	0.7 - 1.2
	5.04	89-03-31	1.04	0.8 - 1.3
	5.04	89-08-25		
	5.05	89-01-20	1.33	0.5 - 2.3
	5.05	89-05-12	1.12	0.7 - 1.3
	5.05	89-09-22	1.23	0.5 - 1.7
Cs-137	5.03	89-04-18	0.97	0.8 - 1.2
	5.03	89-10-31	0.98	0.5 - 1.9
	5.04	89-03-31	0.99	0.7 - 1.5
	5.04	89-08-25	0.92	0.7 - 1.5
	5.06	89-02-10	0.95	0.7 - 1.4
	5.06	89-06-09	0.99	0.8 - 1.3
	5.06	89-10-06	0.99	0.9 - 1.2
	5.08	89-04-28	0.96	0.9 - 1.1
H-3	5.09	89-02-24	0.96	0.8 - 1.2
	5.09	89-06-23	0.93	0.8 - 1.2
	5.09	89-10-20	0.94	0.8 - 1.2
Sr-89	5.03	89-04-18	0.95	0.5 - 1.5
	5.03	89-10-31	1.15	0.5 - 1.3
	5.07	89-01-06	1.01	0.6 - 1.3
	5.07	89-05-05	0.75	0.5 - 1.5
	5.07	89-09-15	1.01	0.6 - 1.3
Sr-90	5.03	89-04-18	0.94	0.7 - 1.3
	5.03	89-10-31	0.99	0.6 - 1.3
	5.04	89-03-31	0.94	0.7 - 1.2
	5.07	89-01-06	1.01	0.8 - 1.1
	5.07	89-05-05	0.98	0.6 - 1.2
	5.07	89-09-15	0.97	0.8 - 1.1

* : Excluding those results significantly different from the population mean.

TABLE 5.03 90-03-12
Point Lepreau Generating Station
Environmental Radiation Monitoring
Quality Assurance Program
89-01-01 to 89-12-31

EPA Lab. Performance Evaluation pCi/L +- 2 sigma

Analysis	Sample Date	EPA	* All Participants	NBEPC	NBEPC/EPA
ALPHA	89-04-18	27 +- 9	26 +- 15	30 +- 2	1.12
	89-10-31	49 +- 17	45 +- 22	54 +- 3	1.10
BETA	89-04-18	57 +- 7	50 +- 15	58 +- 2	1.01
	89-10-31	32 +- 7	31 +- 8	33 +- 2	1.02
Cs-134	89-04-18	20 +- 7	19 +- 5	16 +- 2	0.79
	89-10-31	5 +- 7	5 +- 3	4 +- 1	0.82
Cs-137	89-04-18	20 +- 7	20 +- 5	19 +- 2	0.97
	89-10-31	5 +- 7	6 +- 3	5 +- 1	0.98
Sr-89	89-04-18	8 +- 7	8 +- 4	8 +- 1	0.95
	89-10-31	15 +- 7	14 +- 6	17 +- 1	1.15
Sr-90	89-04-18	8 +- 2	8 +- 2	8 +- 1	0.94
	89-10-31	7 +- 2	7 +- 2	7 +- 0	0.99

* : Excluding those results significantly different from the population mean.

TABLE 5.04 90-03-12
Point Lepreau Generating Station
Environmental Radiation Monitoring
Quality Assurance Program
89-01-01 to 89-12-31

EPA Alpha,Beta,Cs,Sr in Air Filter pCi +- 2 sigma

Analysis	Sample Date	EPA	* All Participants	NBEPC	NBEPC/EPA
ALPHA	89-03-31	21 +- 7	23 +- 9	22 +- 1	1.06
	89-08-25	6 +- 7	7 +- 3	6 +- 0	1.07
BETA	89-03-31	62 +- 7	63 +- 16	64 +- 1	1.04
	89-08-25	0 +- 0	0 +- 0	12 +- 0	
Cs-137	89-03-31	20 +- 7	21 +- 8	20 +- 2	0.99
	89-08-25	10 +- 7	11 +- 4	9 +- 2	0.92
I-131	89-08-25	0 +- 0	0 +- 0	< 3	
Sr-90	89-03-31	20 +- 2	19 +- 6	19 +- 1	0.94

* : Excluding those results significantly different from the population mean.

TABLE 5.05 90-03-12

Point Lepreau Generating Station
Environmental Radiation Monitoring
Quality Assurance Program
89-01-01 to 89-12-31

EPA Gross Alpha/Beta in Water pCi/L +- 2 sigma

Analysis	Sample Date	EPA	* All Participants	NBEPC	NBEPC/EPA
ALPHA	89-01-20	8 +- 7	8 +- 5	9 +- 1	1.10
	89-05-12	30 +- 11	28 +- 15	37 +- 2	1.22
	89-09-22	4 +- 7	4 +- 4	5 +- 1	1.35
BETA	89-01-20	4 +- 7	5 +- 4	5 +- 1	1.33
	89-05-12	50 +- 7	50 +- 16	56 +- 3	1.12
	89-09-22	6 +- 7	7 +- 4	7 +- 1	1.23

* : Excluding those results significantly different from the population mean.

TABLE 5.06 90-03-12
Point Lepreau Generating Station
Environmental Radiation Monitoring
Quality Assurance Program
89-01-01 to 89-12-31

EPA Gamma in Water pCi/L +- 2 sigma

Analysis	Sample Date	EPA	* All Participants	NBEPC	NBEPC/EPA
Ba-133	89-06-09	49 +- 7	48 +- 10	50 +- 4	1.01
	89-10-06	59 +- 8	58 +- 10	55 +- 4	0.94
Co-60	89-02-10	10 +- 7	11 +- 4	10 +- 1	0.98
	89-06-09	31 +- 7	31 +- 6	30 +- 3	0.95
	89-10-06	30 +- 7	30 +- 5	30 +- 3	0.99
Cr-51	89-02-10	235 +- 34	233 +- 41	231 +- 21	0.98
Cs-134	89-02-10	10 +- 7	10 +- 4	9 +- 1	0.88
	89-06-09	39 +- 7	37 +- 7	36 +- 3	0.91
	89-10-06	29 +- 7	27 +- 6	25 +- 2	0.87
Cs-137	89-02-10	10 +- 7	11 +- 4	10 +- 1	0.95
	89-06-09	20 +- 7	21 +- 4	20 +- 2	0.99
	89-10-06	59 +- 7	61 +- 9	58 +- 4	0.99
I-131	89-02-17	106 +- 16	106 +- 14	98 +- 7	0.93
	89-08-04	83 +- 11	84 +- 15	80 +- 5	0.97
Ru-106	89-02-10	178 +- 26	171 +- 30	150 +- 16	0.84
	89-06-09	128 +- 18	123 +- 27	118 +- 14	0.92
	89-10-06	161 +- 23	153 +- 27	140 +- 16	0.87
Zn-65	89-02-10	159 +- 23	160 +- 24	154 +- 10	0.97
	89-06-09	165 +- 24	167 +- 23	161 +- 10	0.98
	89-10-06	129 +- 18	129 +- 18	124 +- 9	0.96

* : Excluding those results significantly different from the population mean.

TABLE 5.07 90-03-12

Point Lepreau Generating Station
Environmental Radiation Monitoring
Quality Assurance Program
89-01-01 to 89-12-31

EPA Sr-89,90 in Water pCi/L +- 2 sigma

Analysis	Sample Date	EPA	* All Participants	NBEPC	NBEPC/EPA
Sr-89	89-01-06	40 +- 7	38 +- 15	40 +- 1	1.01
	89-05-05	6 +- 7	6 +- 3	5 +- 0	0.75
	89-09-15	14 +- 7	13 +- 5	14 +- 1	1.01
Sr-90	89-01-06	25 +- 2	24 +- 4	25 +- 1	1.01
	89-05-05	6 +- 2	6 +- 2	6 +- 0	0.98
	89-09-15	10 +- 2	9 +- 2	10 +- 1	0.97

* : Excluding those results significantly different from the population mean.

TABLE 5.08 90-03-12

Point Lepreau Generating Station
Environmental Radiation Monitoring
Quality Assurance Program
89-01-01 to 89-12-31

EPA Radionuclides in Milk pCi/L +- 2 sigma

Analysis	Sample Date	EPA	* All Participants	NBEPC	NBEPC/EPA
Cs-137	89-04-28	50 +- 7	50 +- 6	48 +- 3	0.96
K(mg/L)	89-04-28	1600 +- 113	1646 +- 238	1666 +- 85	1.04

* : Excluding those results significantly different from the population mean.

TABLE 5.09 90-03-12

Point Lepreau Generating Station
Environmental Radiation Monitoring
Quality Assurance Program
89-01-01 to 89-12-31

EPA Tritium in Water pCi/L +- 2 sigma

Analysis	Sample Date	EPA	* All Participants	NBEPC	NBEPC/EPA
H-3	89-02-24	2750 +- 500	2720 +- 550	2640 +- 270	0.96
	89-06-23	4503 +- 636	4491 +- 768	4187 +- 291	0.93
	89-10-20	3496 +- 515	3471 +- 738	3293 +- 274	0.94

* : Excluding those results significantly different from the population mean.

APPENDICES

6.0 SOURCE EMISSION DATA FROM POINT LEPREAU.

The source emissions data are reproduced from the PLGS Quarterly Technical Reports concerning station operation and data.

Tables 6.01 and 6.02 summarize the emissions from PLGS since 1983. Note that in these tables, the Annual DEL for each radionuclide is indicated whereas in station operation a monthly or weekly DEL is used in monitoring. Based upon the total % DEL for all monitored radionuclides in each pathway for the year, the calculated whole body radiation dose to members of a hypothetical Critical Group residing at the boundary fence all year was about 0.07 microsievert from liquid effluent emissions and 0.7 microsievert from airborne effluent emissions (0.7 in 1987 and 1988). Because of the protective assumptions used in the DEL calculations, no member of the general public received these dose levels. This calculated radiation dose may be compared with the natural radiation dose in the Point Lepreau area of approximately 3000 microsieverts per annum (including natural dose contributions from ground, air, food and from radon in homes).

Figure 6.1 shows the power level achieved since 1982, on a monthly basis. Figures 6.2 and 6.3 show the levels of emission of tritium and I-131 in the liquid effluent pathway, and Figure 6.4 shows the level of tritium emission in the gaseous effluent pathway.

The information for the Liquid Effluent and Airborne pathways from PLGS is used not only to control the frequency of sample collection in the Environmental Monitoring Program but also to indicate which pathways and sample types may need to be more closely examined.

To the present time, tritium and C-14 are the only radionuclides detected off site which are attributable to the operation of PLGS. The correlation between observed and expected tritium levels in the air monitoring stations over the last five years, indicates that in the airborne pathway, the assumed Dilution Factor of 2.2E-07 s/m^3 used in the DEL licensing document is sufficiently accurate.

TABLE 6.01

Liquid Effluent Pathway Emission Data (%DEL)

Radio-nuclide	ANNUAL DEL (Bq)	1983	1984	1985	1986	1987	1988	1989
H-3	5E+19	1.9E-5	1.5E-4	5.1E-5	2.3E-4	2.0E-4	2.5E-4	6.8E-4
C-14	1E+15	.....	.....	.....	.....	.....	.....	8.2E-6
Cr-51	2E+16	3.2E-6	4.7E-5	1.2E-7	9.0E-8	3.4E-8	.....	1.6E-7
Mn-54	2E+14	1.2E-7	9.2E-5	6.0E-7	8.3E-6	4.1E-7	4.6E-7	5.6E-6
Co-58	8E+14	.....	1.0E-6	.....	.....	.....	.....	.....
Fe-59	1E+14	1.6E-5	7.2E-5	1.6E-6	.....	1.3E-6	1.2E-6	7.4E-6
Co-60	4E+14	2.3E-6	8.1E-5	4.1E-6	1.2E-5	3.3E-6	4.9E-6	4.3E-5
Zn-65	1E+14	.....	4.1E-7	1.8E-7	7.5E-6	.....	.....	2.7E-6
Sr-90	2E+15	.....	2.2E-8	3.8E-10	6.0E-7	4.0E-8		4.0E-8
Zr-95	7E+14	7.4E-6	3.9E-5	1.7E-5	4.8E-5	2.0E-5	7.8E-6	2.9E-5
Nb-95	7E+14	1.2E-5	7.1E-5	2.9E-5	8.2E-5	3.2E-5	1.5E-5	5.9E-5
Ru-103	1E+15	4.6E-7	5.7E-9	4.2E-7	9.1E-7	2.4E-7	3.3E-7	.....
Ru-106	2E+14	.....	1.3E-6	.....	.....	.....	.....	.....
Ag-110m	1E+14	1.8E-7	7.3E-8	4.0E-7	4.9E-6	1.4E-6	4.7E-6	3.6E-7
Sb-124	1E+13	.....	.....	.....	.....	.....	.....	6.5E-4
I-131	1E+14	1.4E-3	3.4E-5	8.2E-4	3.3E-5	1.0E-7	6.8E-4	2.3E-5
Cs-134	5E+14	1.8E-7	2.3E-6	6.7E-8	3.7E-7	4.7E-7	9.0E-7	5.2E-8
Cs-137	8E+14	.....	7.6E-6	7.9E-7	3.1E-6	1.7E-6	3.4E-6	1.4E-6
La-140	2E+15	3.6E-8	1.1E-8	.....	.....	.....	.....	.....
Ba-140	2E+15	.....	.....	.....	.....	.....	.....	.....
Ce-141	2E+15	2.5E-8	1.1E-8	.....	.....	.....	8.1E-9	.....
Ce-144	2E+14	3.3E-6	8.1E-7	5.4E-7	1.6E-6	4.7E-7	3.0E-7	.....
Total % DEL		1.5E-3	6.0E-4	9.3E-4	4.3E-4	2.6E-4	9.7E-4	1.5E-3

Calculated annual dose in microsievert:

Whole body -	1.4E-2	2.9E-2	1.3E-2	2.0E-2	1.3E-2	2.1E-2	7.5E-2
Thyroid -	3.0E-1	3.8E-2	2.5E-1	3.0E-2	1.3E-2	2.2E-1	8.2E-2

The liquid effluent DEL for I-131 is based upon an adult-limiting thyroid dose of 30 millisievert per annum.

The whole body dose represents the dose calculated from all radionuclides emitted except I-131, but includes the 0.03 weighted contribution of the adult thyroid dose from I-131.

The thyroid dose is the I-131 thyroid dose plus the whole body dose.

TABLE 6.02

Gaseous Effluent Pathway Emission Data (%DEL)

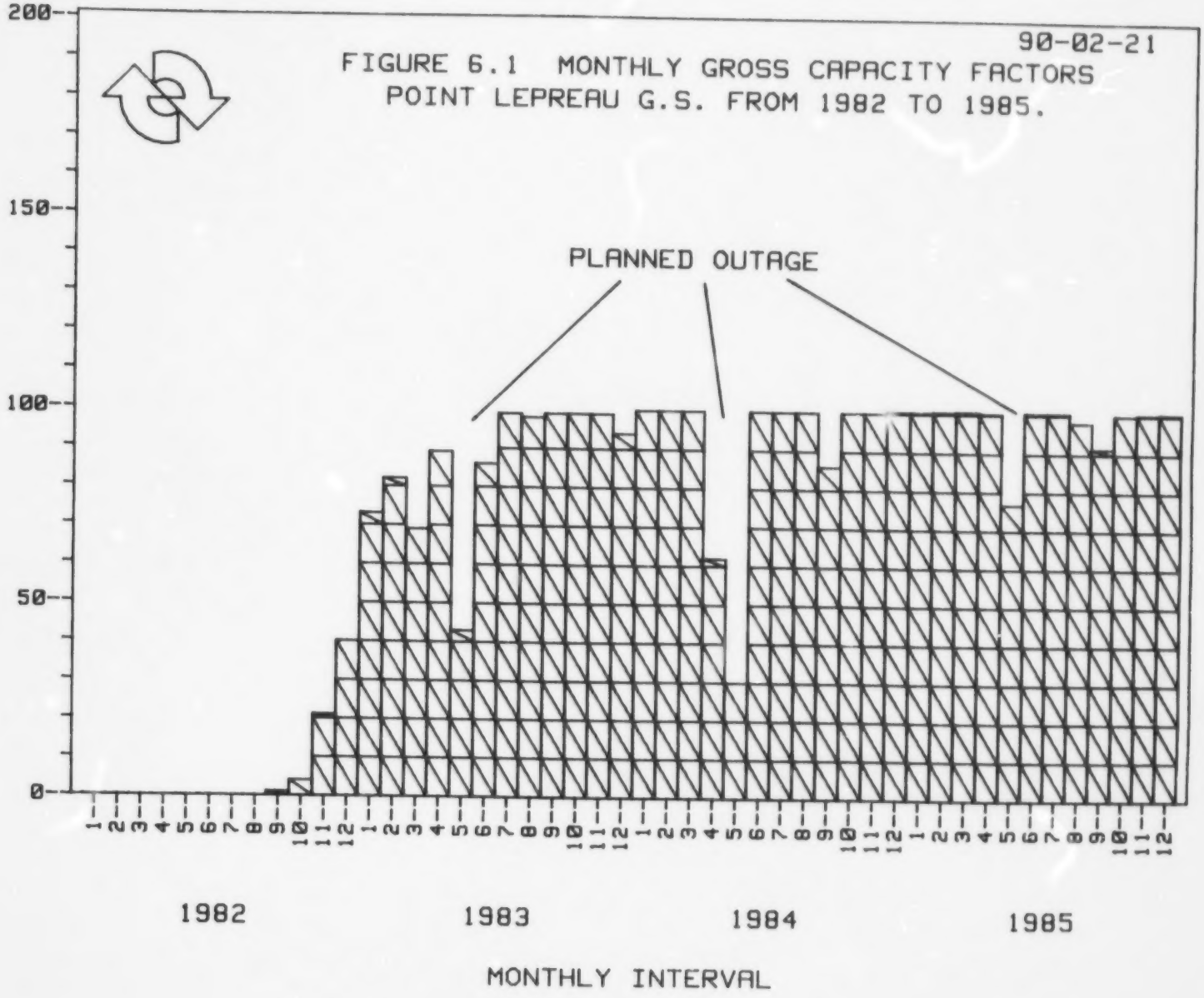
Radio-nuclide	ANNUAL DEL (Bq)	1983	1984	1985	1986	1987	1988	1989
H-3	2E+18	1.6E-3	4.3E-3	6.8E-3	1.3E-2	1.4E-2	1.4E-2	1.3E-2
C-14 *	2E+16	.....	.....	.....	.....	.....	.....	2.6E-3
Co-60	5E+14	.....	.....	.....	.....	.....	.....	.....
Ru-106	2E+14	.....	.....	.....	.....	.....	.....	.....
I-131	3E+12	3.6E-4	.....	1.5E-4	1.1E-3	.....	1.8E-3	1.9E-4
Cs-134	1E+14	.....	.....	.....	.....	.....	.....	.....
Cs-137	3E+14	.....	.....	.....	.....	.....	.....	.....
Noble G	4E+17	1.2E-3	.....	2.5E-4	1.5E-3	2.7E-5	9.6E-5	.....
Total % DEL		3.2E-3	4.3E-3	7.2E-3	1.6E-2	1.4E-2	1.6E-2	2.9E-2

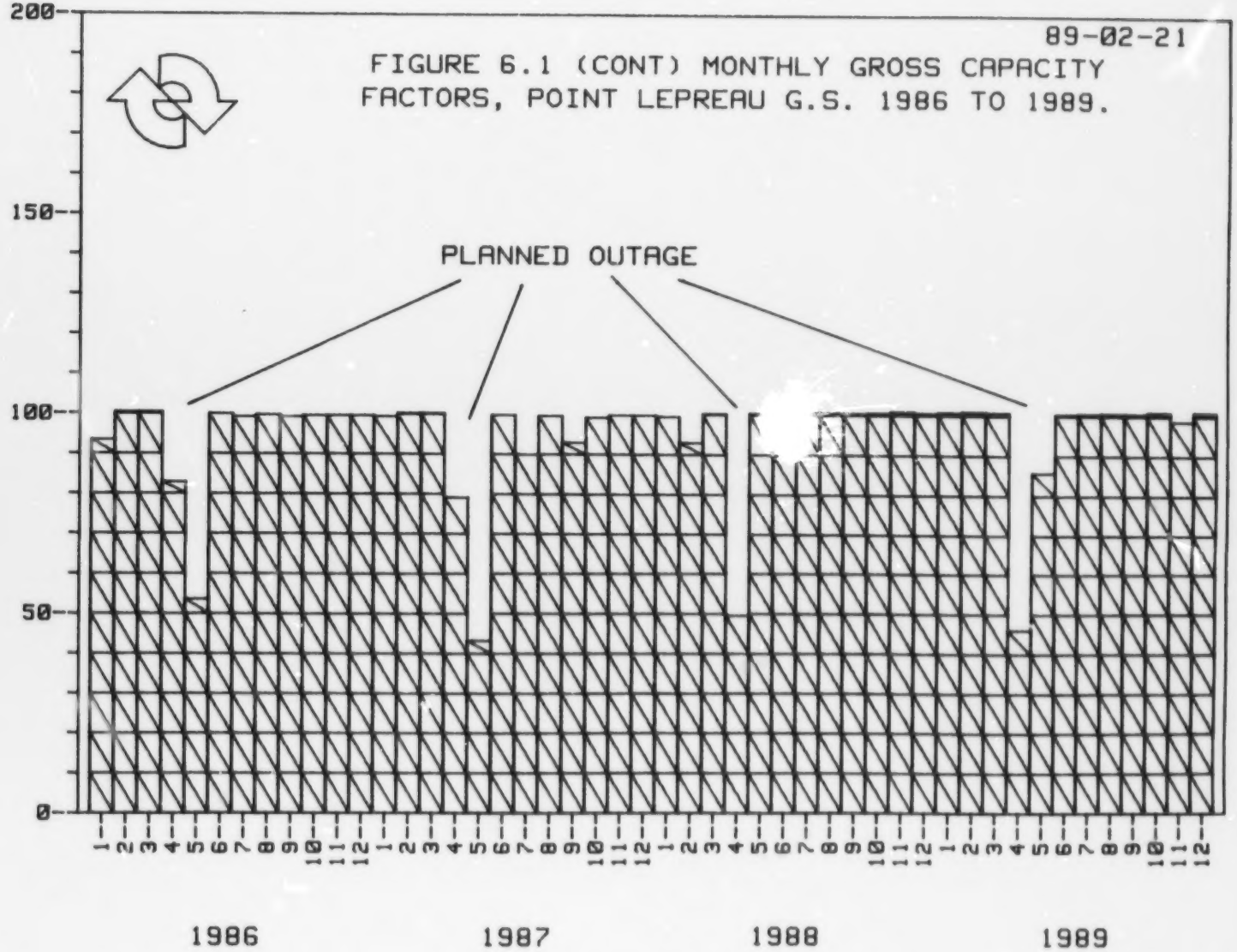
* This DEL assumes a cow at 1.5 km from the stack. The nearest cow in 1989 was at least 40 km distant. The C-14 DEL with the cow at 40 km becomes 1E+17 Bq/a, and the % DEL becomes 3.0E-4, used in the calculation below. This assumes that the infant living at the boundary drinks milk produced 40 km away.

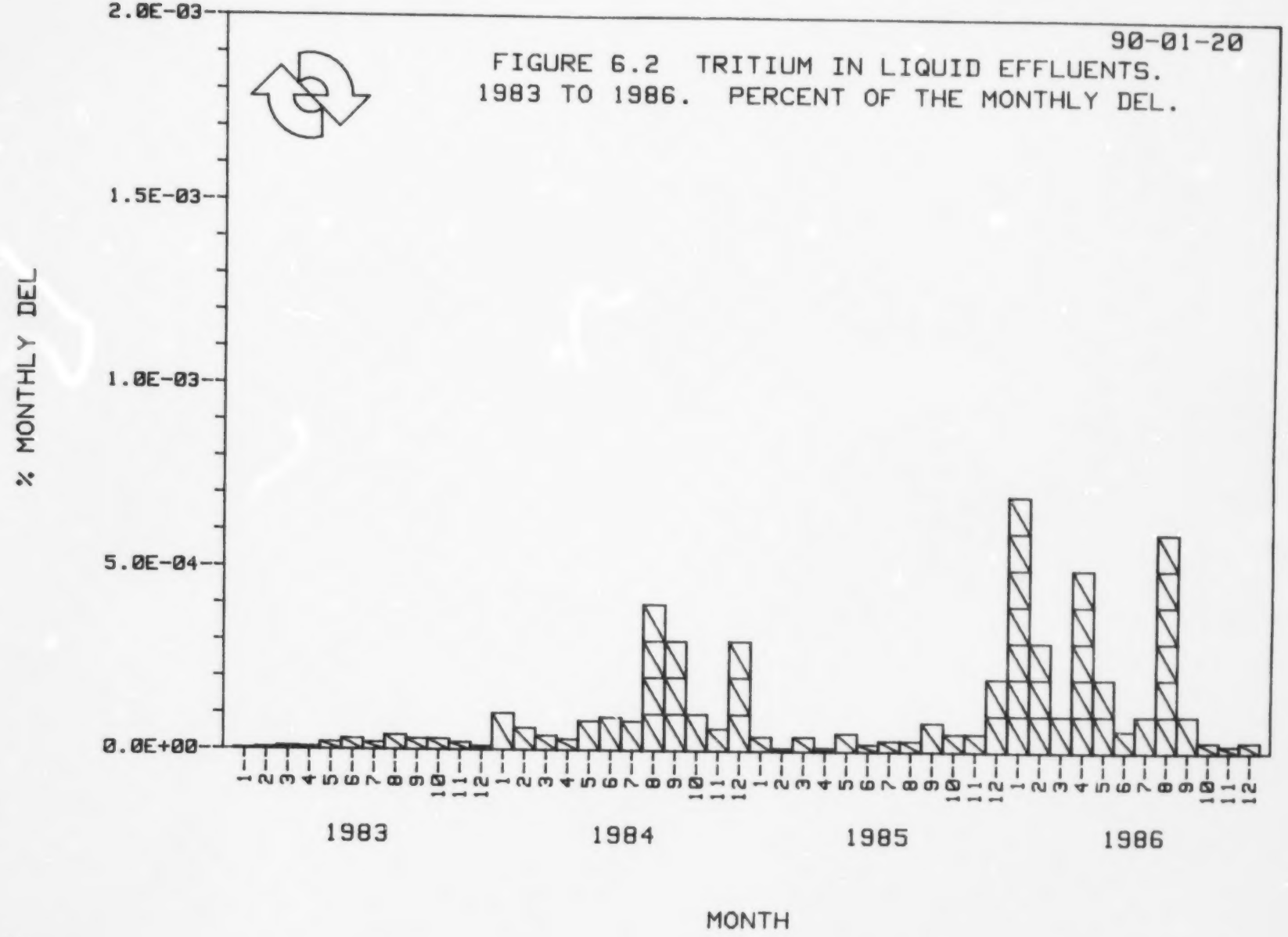
Calculated annual dose (at the boundary fence) in microsievert:

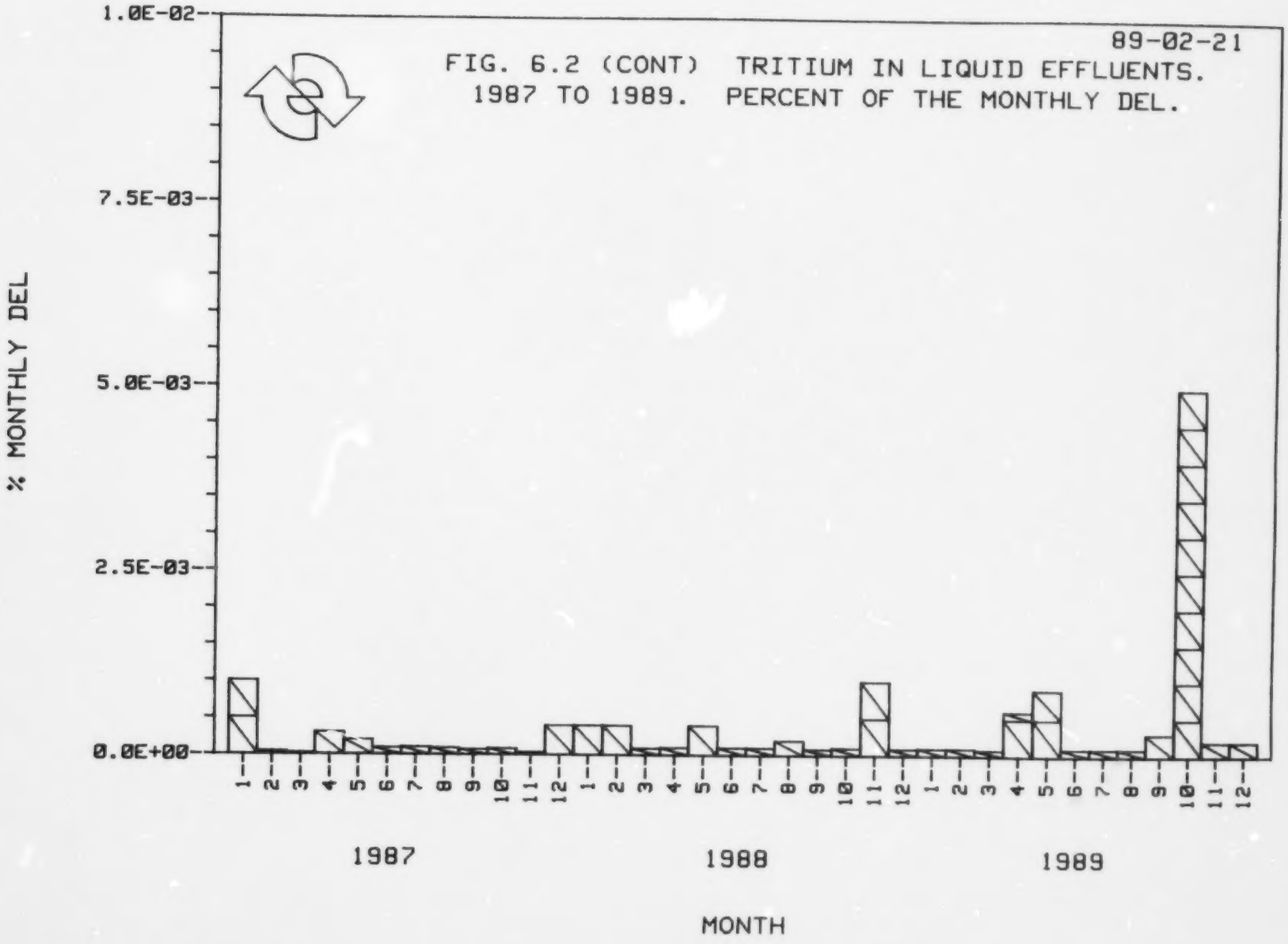
Whole body -	1.4E-1	2.2E-1	3.5E-1	7.3E-1	7.0E-1	7.1E-1	6.7E-1
Thyroid -	1.9E-1	2.2E-1	3.8E-1	8.9E-1	7.0E-1	9.7E-1	6.9E-1

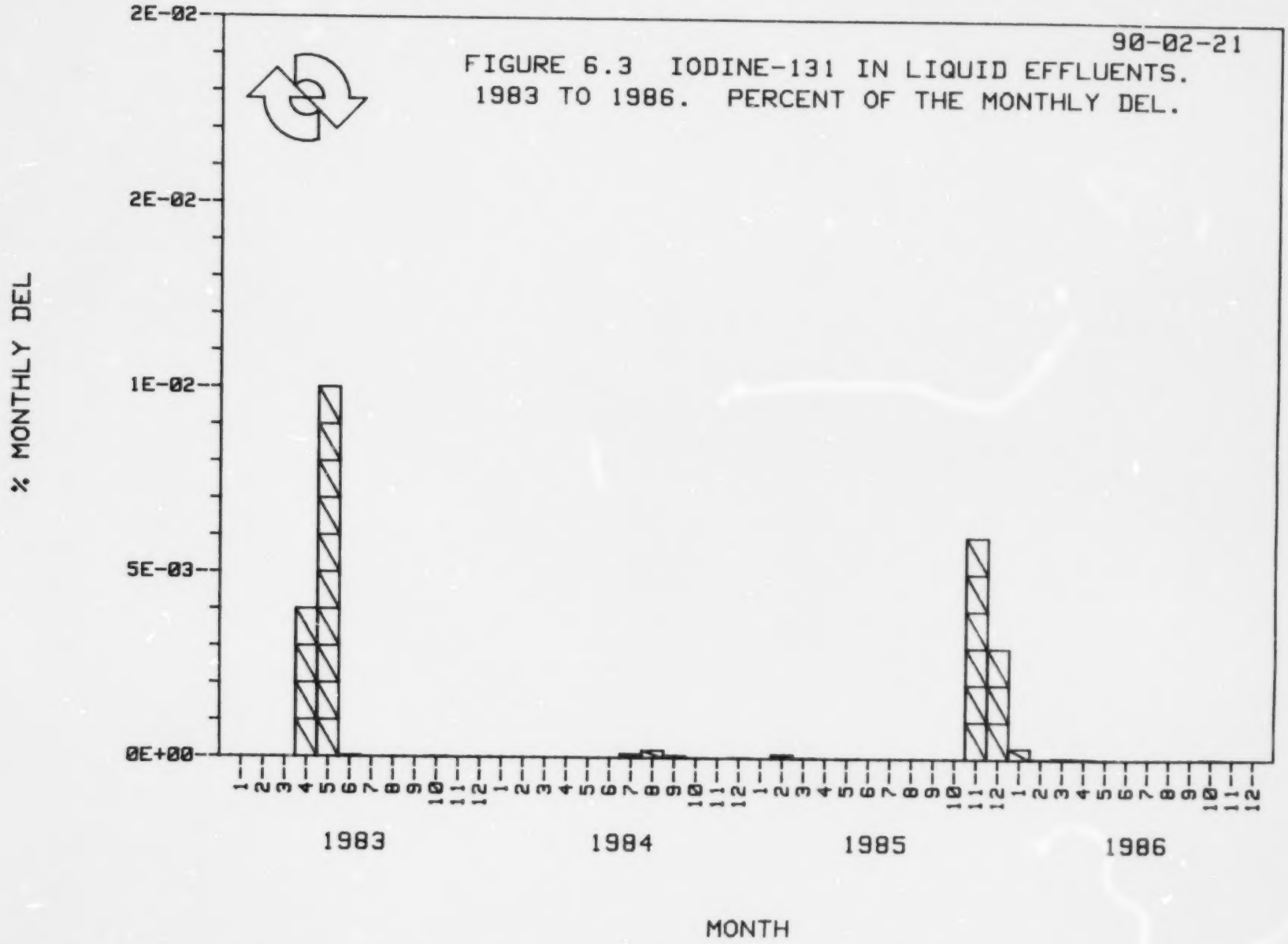
The airborne DEL for I-131 is based on the infant limiting thyroid dose of 15 millisievert per annum. The calculated whole body dose is an approximation, as it is based on the DELs that apply to the adult, but includes the 0.03 component of the infant thyroid dose.

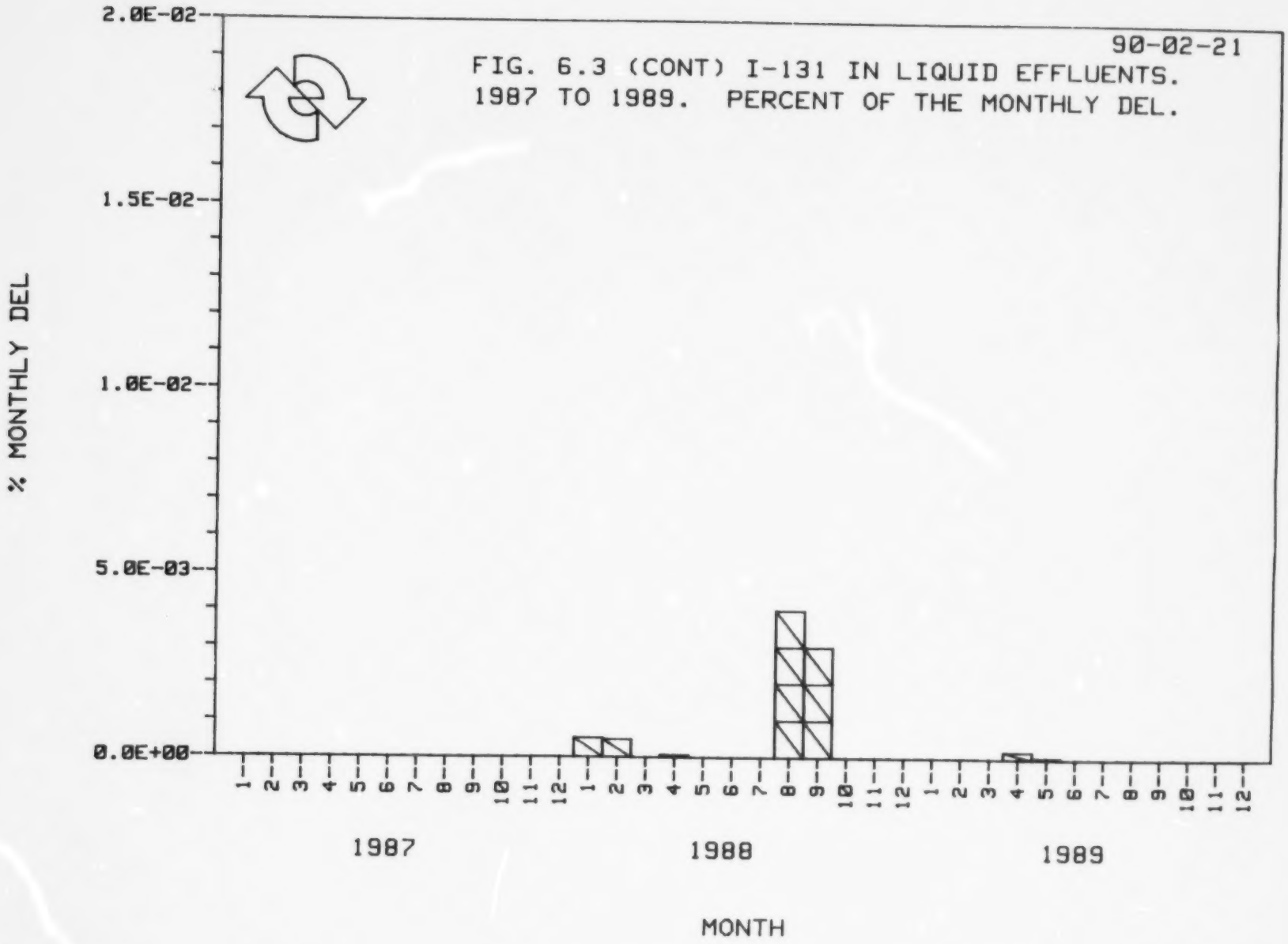

90-02-21
FIGURE 6.1 MONTHLY GROSS CAPACITY FACTORS
POINT LEPREAU G.S. FROM 1982 TO 1985.
PLANNED OUTAGE
%
200
150
100
50
0
1982
1983
1984
1985
MONTHLY INTERVAL

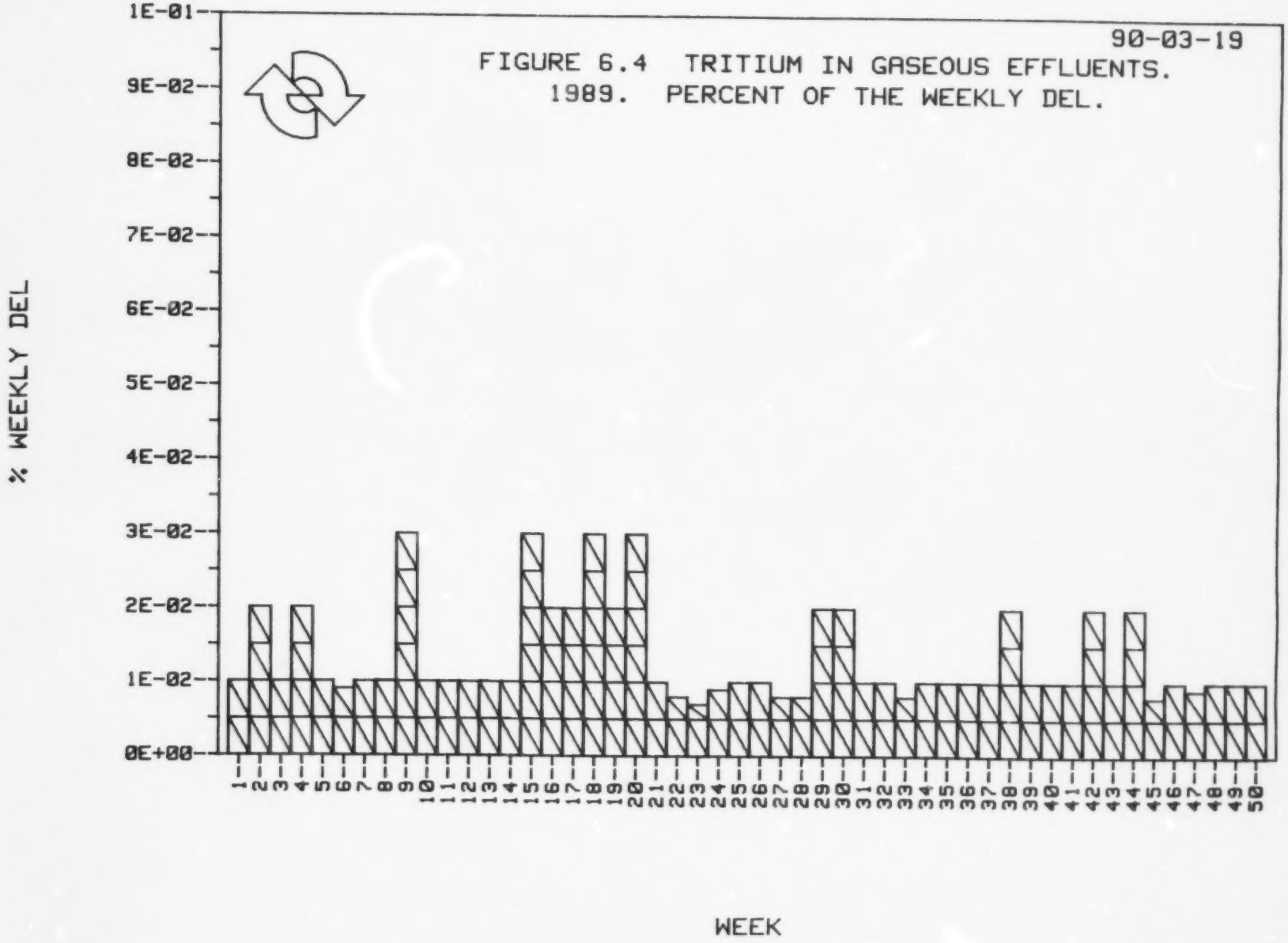

89-02-21
FIGURE 6.1 (CONT) MONTHLY GROSS CAPACITY FACTORS, POINT LEPREAU G.S. 1986 TO 1989.
PLANNED OUTAGE
200
150
100
50
0
1986
1987
1988
1989
MONTHLY INTERVAL


90-01-20
FIGURE 6.2 TRITIUM IN LIQUID EFFLUENTS.
1983 TO 1986. PERCENT OF THE MONTHLY DEL.
2.0E-03
1.5E-03
1.0E-03
5.0E-04
0.0E+00
% MONTHLY DEL
1983
1984
1985
1986
MONTH


89-02-21
FIG. 6.2 (CONT) TRITIUM IN LIQUID EFFLUENTS.
1987 TO 1989. PERCENT OF THE MONTHLY DEL.
% MONTHLY DEL
1.0E-02
7.5E-03
5.0E-03
2.5E-03
0.0E+00
1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
1987
1988
1989
MONTH


90-02-21
FIGURE 6.3 IODINE-131 IN LIQUID EFFLUENTS.
1983 TO 1986. PERCENT OF THE MONTHLY DEL.
% MONTHLY DEL
2E-02
2E-02
1E-02
5E-03
0E+00
1983
1984
1985
1986
MONTH


90-02-21
FIG. 6.3 (CONT) I-131 IN LIQUID EFFLUENTS.
1987 TO 1989. PERCENT OF THE MONTHLY DEL.
% MONTHLY DEL
2.0E-02
1.5E-02
1.0E-02
5.0E-03
0.0E+00
1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
1987
1988
1989
MONTH


90-03-19
FIGURE 6.4 TRITIUM IN GASEOUS EFFLUENTS.
1989. PERCENT OF THE WEEKLY DEL.
% WEEKLY DEL
1E-01
9E-02
8E-02
7E-02
6E-02
5E-02
4E-02
3E-02
2E-02
1E-02
0E+00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50
WEEK

7.0 METEOROLOGICAL DATA AROUND POINT LEPREAU G.S.

The meteorological data for the 10 metre weather tower in the Point Lepreau area for 1989 and a compilation of the 1986 to 1989 data are presented in Tables 7.01 and 7.02. Data are collected hourly over the year, but gaps in collection due to breakdown occur to the extent of about 5 to 10% in the year. Wind Rose data for both 1989 and the composite data from 1986 to 1989 are presented in Figures 7.1 and 7.2 and a pie-plot of the average percentage frequency of Pasquill stability classes for these four years in the Point Lepreau area is presented in Figure 7.3.

As long term weather data are not available for this location, data for a recent twenty year interval for both Saint John and Fredericton, the nearest locations for which such data are available, are presented in Tables 7.03 and 7.04.

TABLE 7.01

METEOROLOGICAL DATA FOR POINT LEPREAU, NEW BRUNSWICK (1989)

Month	Temperature Mean daily Av	Mean daily Max	Mean daily Min	Extreme Max	Extreme Min	Wind direction % Observations From N	NE	E	SE	S	SW	W	NW	A	Pasquill stability classes B	C	D	E	F	G	UNAV.
	°C	°C	°C	°C	°C	*	Relative %								Relative %						%
January	-4.4	0.3	-9.2	5.3	-21.1	10	6	6	3	12	12	17	33	20	12	9	24	21	11	3	2
February	-5.8	-2.6	-9.4	5.8	-19.0	19	9	4	1	7	22	18	20	15	11	14	26	19	11	4	#
March	-2.9	0.1	-6.4	7.1	-24.5	17	12	4	1	13	18	13	22	14	7	8	33	24	9	4	#
April	1.9	4.2	0.3	8.3	-1.1	7	21	11	4	15	24	13	5	9	5	7	15	38	24	2	50
May	9.5	12.5	7.1	17.8	4.0	3	13	15	5	16	28	16	4	5	3	2	16	31	24	18	49
June	11.9	15.0	9.2	22.1	6.1	10	19	12	5	13	19	14	7	1	1	2	11	35	30	20	4
July	13.3	16.2	10.9	25.3	8.6	7	5	7	4	26	26	16	9	1	2	2	9	32	31	23	6
August	13.4	16.1	11.1	22.0	8.0	1	0	5	5	25	27	23	13	3	2	2	8	28	40	18	10
September	12.2	14.7	9.6	25.6	1.1	10	9	7	3	18	20	20	14	3	1	3	15	36	28	12	11
October	8.0	10.5	5.4	15.4	0.1	7	10	7	4	13	23	28	8	4	3	6	32	23	20	13	6
November	1.7	4.7	-1.5	13.1	-13.1	12	13	4	7	12	12	22	17	6	4	7	27	28	22	6	1
December	-10.7	-6.8	-14.9	3.9	-21.5	10	2	2	2	2	4	26	52	22	12	11	26	19	7	3	27
Means	4.0	7.3	1.2	25.6	-24.5	10	9	7	4	14	19	19	17	9	5	6	21	27	21	11	14
Years	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

10 Metre Tower data.

* Each compass direction covers ± 22.5 degrees.

UNAV means that percentage of time that the instrumentation was unavailable and could not record the weather.

\# means unavailable less than 1% of the time.

TABLE 7.02

METEOROLOGICAL DATA FOR POINT LEPREAU, NEW BRUNSWICK

Month	Temperature Mean daily Av	Mean daily Max	Mean daily Min	Extreme Max	Extreme Min	Wind direction % Observations From N	NE	E	SE	S	SW	W	NW	A	Pasquill stability classes B	C	D	E	F	G	UNAV.
	°C	°C	°C	°C	°C	*	Relative %								Relative %						%
January	-5.0	-1.0	-9.1	9.4	-24.0	15	8	8	5	8	11	16	29	26	11	9	24	18	8	4	10
February	-5.4	-2.1	-9.4	5.8	-21.0	17	9	4	2	7	13	17	31	25	14	14	24	15	6	2	#
March	-1.7	1.4	-5.0	13.3	-24.5	17	14	6	2	12	15	12	21	19	9	10	27	23	8	5	2
April	3.5	6.1	1.2	15.0	-4.3	18	27	13	5	14	11	6	6	12	7	8	26	32	11	4	14
May	7.7	10.8	5.3	22.7	-1.0	8	19	11	3	20	23	10	6	9	5	7	23	32	13	10	19
June	11.1	14.3	8.5	24.0	4.3	6	14	14	4	15	22	15	9	4	3	3	16	37	22	15	2
July	13.3	16.2	10.9	25.3	6.5	5	9	10	4	22	27	16	7	2	2	2	12	35	27	21	5
August	13.7	16.4	11.3	23.1	7.9	7	6	9	5	18	25	21	9	3	1	2	11	32	32	19	9
September	11.6	14.2	9.2	25.6	1.1	7	8	4	3	14	27	20	15	5	2	4	19	37	23	10	9
October	7.8	10.2	5.3	18.6	-1.3	11	8	7	6	14	21	20	14	6	5	7	33	28	13	8	3
November	2.6	5.5	-0.6	13.1	-13.1	12	8	4	5	13	12	22	24	10	6	10	35	24	12	3	1
December	-4.6	-0.9	-8.3	10.2	-21.5	18	7	4	3	4	8	24	33	20	12	12	29	19	6	2	7
Means	4.5	7.7	1.7	25.6	-24.5	12	11	8	4	13	18	17	17	12	6	7	23	28	15	9	7
Years	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4

10 Metre Tower data, 1986-01-01 to 1989-12-31.

* Each compass direction covers ± 22.5 degrees.

UNAV means that percentage of time that the instrumentation was unavailable and could not record the weather.

\# means unavailable less than 1% of the time.

TABLE 7.03

METEOROLOGICAL DATA FOR SAINT JOHN, NEW BRUNSWICK(*)

Month	P	Av	Temperature Mean daily Max	Mean daily Min	Extreme Max	Extreme Min	RH	CC	Precip Av	Precip 24h	Days with r	s	ppt	f	th	N	Wind direction % Observations From NE	E	SE	S	SW	W	NW	c	ms
	kPa	°C	°C	°C	°C	°C	%	%	mm	mm															knots
Jan	101.4	-7.4	-2.3	-12.6	11.1	-31.1	82	64	145.0	69.3	6	14	17	3	0.2	22	6	7	4	5	7	18	27	4	11.3
Feb	101.2	-7.5	-2.1	-12.9	10.6	-36.7	80	59	130.8	95.0	5	12	14	3	0.1	19	7	8	5	8	9	18	22	4	11.1
Mar	101.3	-2.6	2.0	-7.3	13.9	-30.0	77	63	104.7	54.6	7	10	14	5	0.1	22	8	9	5	9	8	15	21	3	11.5
Apr	101.4	3.1	7.9	-1.8	20.0	-16.7	75	65	111.8	125.5	11	4	13	6	0.7	20	7	8	8	16	11	11	14	5	10.4
May	101.4	8.8	14.3	3.2	30.0	-7.8	72	68	101.9	62.0	14	1	14	10	0.8	12	6	9	9	25	16	7	11	5	10.1
Jun	101.3	13.6	19.1	8.0	31.7	-2.2	77	70	94.5	54.1	13	0	13	12	2.7	10	6	8	9	33	17	5	7	5	9.7
Jul	101.4	16.9	22.3	11.4	32.8	1.1	80	65	89.4	72.6	12	0	12	17	3.0	7	3	6	8	39	17	7	7	6	8.8
Aug	101.5	16.3	21.7	10.9	31.1	-0.6	82	60	98.8	125.2	12	0	12	14	2.5	9	4	4	8	33	16	9	10	7	8.6
Sep	101.8	12.7	17.8	7.4	28.9	-6.7	82	57	102.6	74.9	12	0	12	13	1.1	12	6	7	7	25	13	9	13	8	9.0
Oct	101.7	7.9	12.7	3.1	25.6	-9.4	83	57	109.7	85.3	11	1	12	9	0.6	15	7	5	7	19	14	14	14	5	10.1
Nov	101.5	2.6	6.6	-1.6	21.7	-14.4	85	68	154.4	73.4	13	4	15	5	0.2	19	7	7	8	12	8	16	19	4	10.8
Dec	101.5	-4.6	-0.2	-9.1	15.0	-26.7	82	62	156.7	105.7	8	12	16	3	0.1	22	7	5	5	7	7	17	26	4	11.2
Means	101.5	5.0	10.0	-0.1												15	6	7	7	20	12	12	16	5	10.3
Totals									1400		123	58	164	99	12.1										
Extremes					32.8	-36.7				125.5															
Years	20	22	22	22	22	22	10	13	22	22	22	22	22	30	20	18	18	18	18	18	18	18	18	18	18

* Data from "Small Craft Guide to the Saint John River." available from the Lower Saint John River Promotion Association, Box 210, Gagetown, N.B. and bookstores.

P	means Mean Sea Level Pressure in kiloPascals.
Av	means Average Monthly Temperature.
RH	means Relative Humidity in percent.
CC	means Cloud Cover in percent.
Precip. mm	means average total precipitation in millimetres for the month.
Precip. max	means maximum precipitation in millimetres recorded in 24 hours.
r,s,ppt,f,th	means days with rain, snow, precipitation, fog and thunder respectively.
c	means percentage of observations that are calm weather.
ms	means mean wind speed in knots.

TABLE 7.04

METEOROLOGICAL DATA FOR FREDERICTON, NEW BRUNSWICK(*)

Month	P	Av	Temperature Mean daily Max	Mean daily Min	Extreme Max	Extreme Min	RH	CC	Precip. Av	Precip. 24h	Days with r	s	ppt	f	th	Wind direction % Observations From N	NE	E	SE	S	SW	W	NW	c	ms
	kPa	°C	°C	°C	°C	°C	%	%	mm	mm															knots
Jan	101.6	-8.8	-3.7	-14.0	11.1	-33.9	72	61	95.3	38.4	5	12	15	2	0.0	7	9	4	2	7	15	28	16	12	8.2
Feb	101.2	-8.1	-2.3	-13.8	13.3	-37.2	73	59	92.5	51.8	3	11	13	2	0.0	6	12	5	2	10	14	26	13	12	8.2
Mar	101.2	-2.4	2.5	-7.4	22.2	-24.4	70	61	69.1	37.9	5	9	12	2	0.1	10	13	7	2	9	10	23	17	9	8.7
Apr	101.3	4.2	9.6	-1.3	24.4	-14.4	64	64	73.9	58.7	10	4	12	2	0.5	11	12	7	4	14	10	17	15	10	8.1
May	101.3	10.6	16.9	4.1	32.8	-6.7	62	65	81.3	83.8	13	0	13	2	1.1	8	11	7	5	21	13	14	13	8	8.0
Jun	101.2	16.1	22.6	9.6	35.0	0.0	67	66	79.3	69.9	13	0	13	3	2.2	6	10	5	6	30	15	12	8	8	7.5
Jul	101.3	19.2	25.6	12.8	36.7	1.7	70	57	88.1	69.1	12	0	12	4	3.8	4	5	3	5	34	17	13	8	11	6.9
Aug	101.4	18.1	24.3	11.7	36.1	1.7	72	58	87.6	76.5	11	0	11	4	3.0	3	5	3	5	30	18	16	9	11	6.7
Sep	101.6	13.4	19.6	7.2	32.8	-2.8	75	54	81.8	71.9	10	0	10	6	0.7	5	8	4	4	24	17	16	11	11	6.7
Oct	101.7	7.8	13.3	2.3	27.8	-8.9	77	59	88.1	54.6	11	1	11	5	0.5	7	9	3	3	20	17	18	12	11	7.3
Nov	101.5	1.7	6.0	-2.6	21.1	-17.8	80	66	109.2	81.0	11	5	14	5	0.1	8	12	5	4	13	15	20	12	11	7.5
Dec	101.5	-6.2	-1.5	-10.8	15.0	-32.2	77	62	114.1	81.3	6	12	15	3	0.1	7	9	4	2	9	15	26	15	13	7.9
Means	101.4	5.5	11.1	-0.2												7	10	4	3	19	15	19	12	11	7.7
Totals									1060		110	54	151	40	12.1										
Extremes					36.7	-37.2				83.8															
Years	20	20	20	20	20	20	10	10	20	20	20	20	20	30	20	18	18	18	18	18	18	18	18	18	18

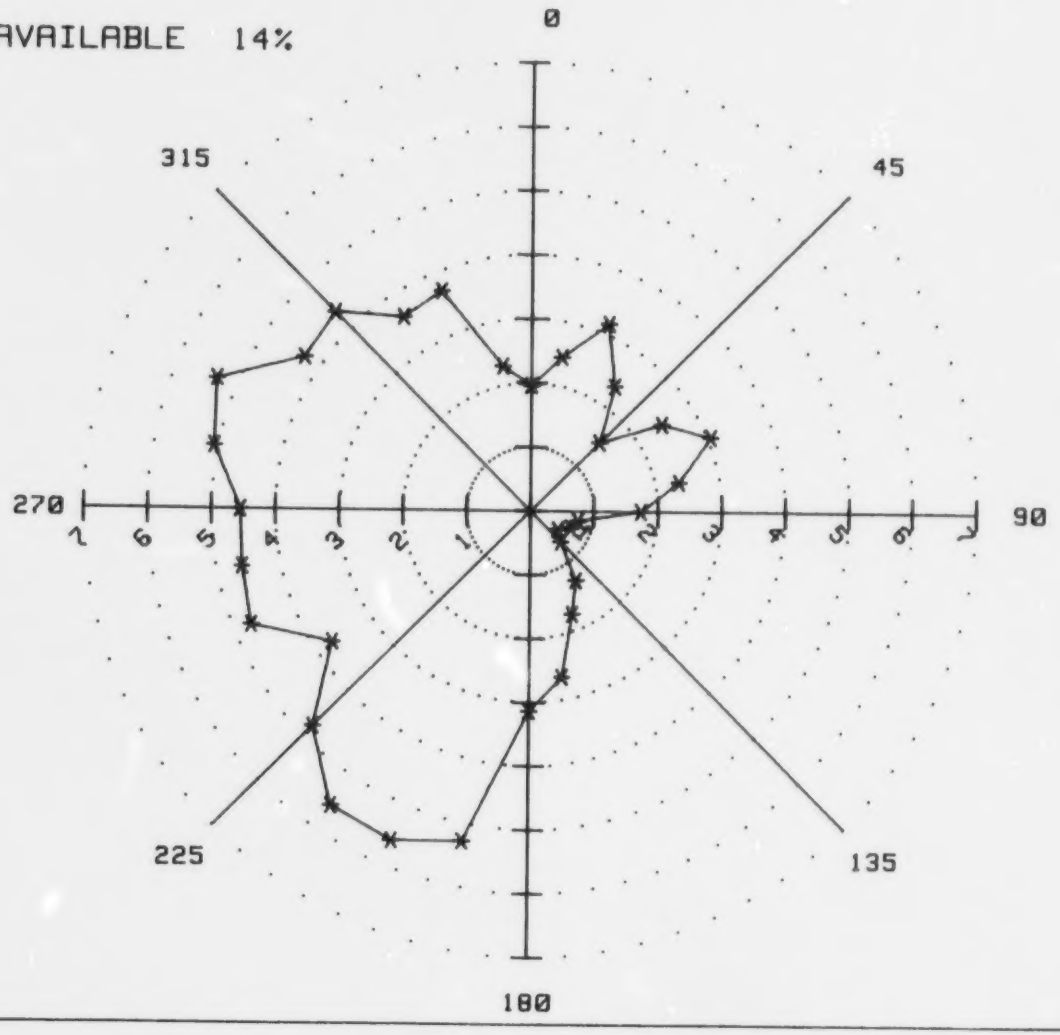
* Data from "Small Craft Guide to the Saint John River." available from the Lower Saint John River Promotion Association, Box 210, Gagetown, N.B. and bookstores.

P	means Mean Sea Level Pressure in kiloPascals.
Av	means Average Monthly Temperature.
RH	means Relative Humidity.
CC	means Cloud Cover in percent.
Precip. mm	means average total precipitation in millimetres for the month.
Precip. max	means maximum precipitation in millimetres recorded in 24 hours.
r,s,ppt,f,th	means days with rain, snow, precipitation, fog and thunder respectively.
c	means percentage of observations that are calm weather.
ms	means mean wind speed in knots.

90-01-20

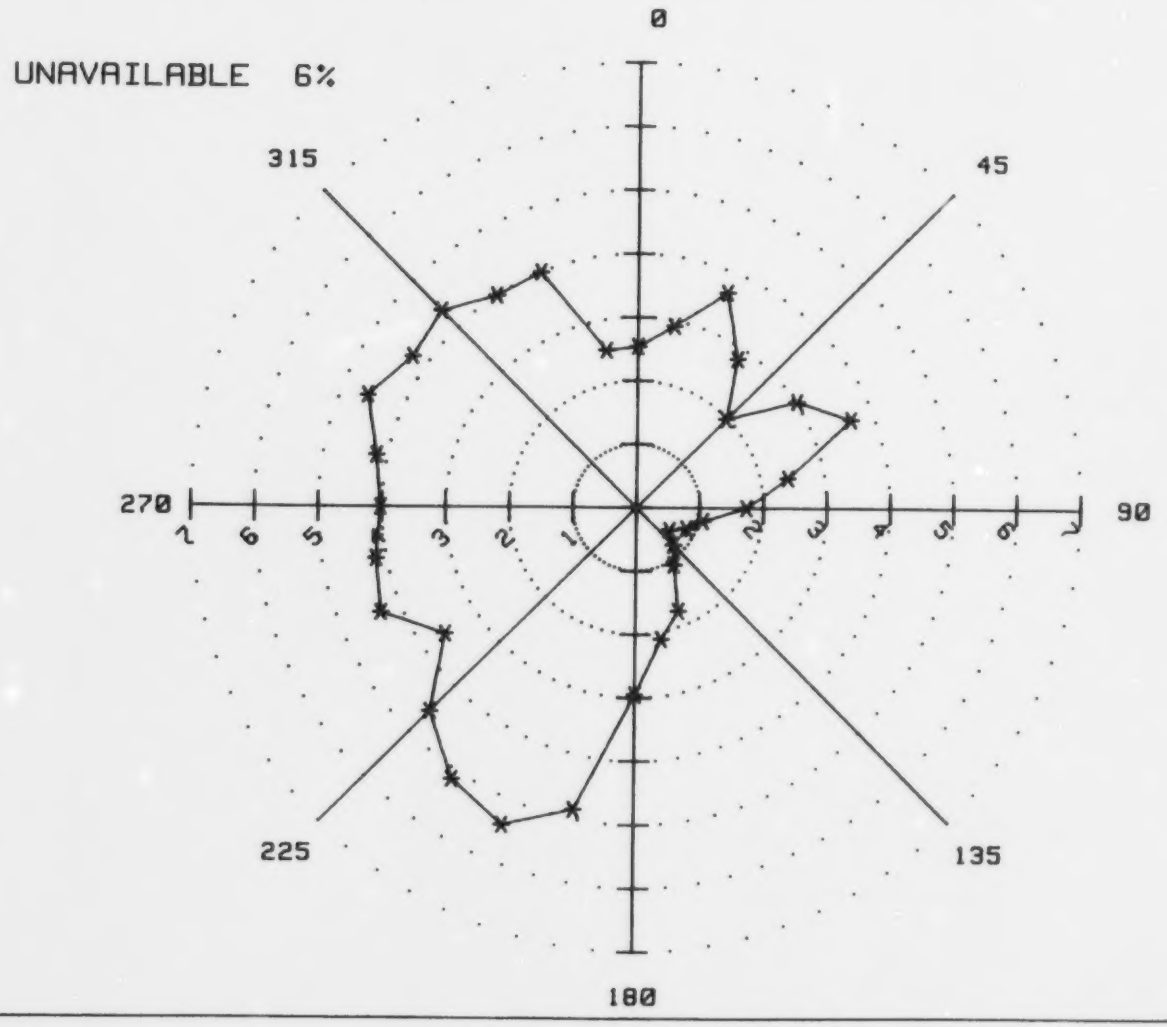
FIGURE 7.1 WIND ROSE DATA FOR 1989.
PERCENT FREQUENCY, POINT LEPREAU, N.B.

UNAVAILABLE 14%



90-01-20

FIGURE 7.2 COMPOSITE WIND ROSE DATA.
% FREQUENCY, POINT LEPREAU, N.B., 1986-1989

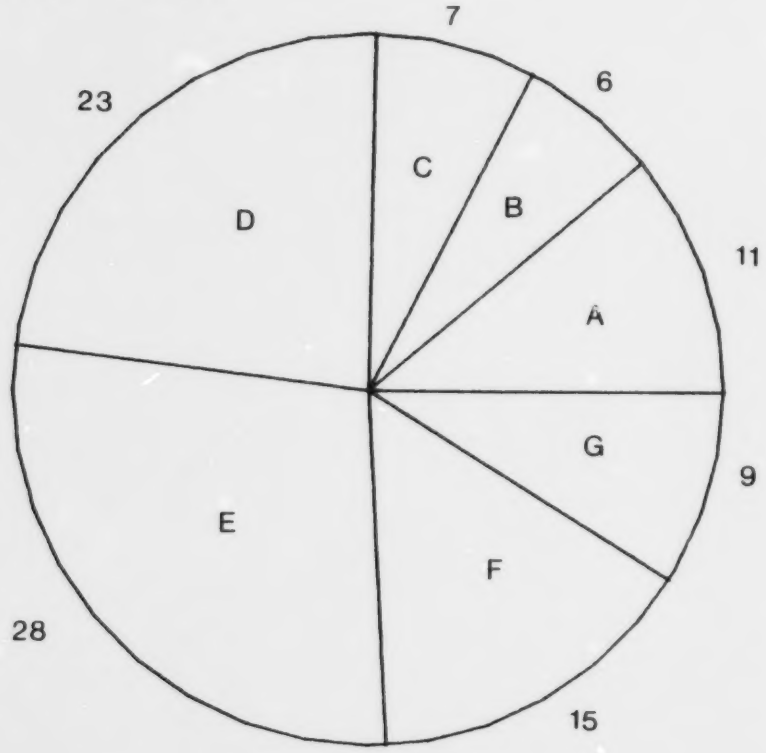


90-02-21

FIGURE 7.3 PASQUILL STABILITY CLASSES
PERCENT FREQUENCY, POINT LEPREAU 1986 TO 1989

UNITS: %

4 YEAR COMPOSITE
UNAVAILABLE 6.43%



8.0 STATISTICS, ANALYTICAL TECHNIQUES, SAMPLE COLLECTION

8.1 Introduction

This section provides a summary of statistics, analytical techniques, analyses and detection limits used in the Health Physics Environmental Laboratory.

8.2 Statistics

The following statistical conventions are applied in the analysis of each sample:

1) Detection limits are defined following the method described by Lochamy (NBS Special Publication 456 - Measurements for the Safe Use of Radiation, U.S. Department of Commerce, 1976). The Lower Limit of Detection (LLD) at the 99% confidence level is defined as 6.58 Sb, where Sb is the standard deviation of the appropriate, ill-defined, background measurement. Such an ill-defined background is typical of the germanium detector analyses, liquid scintillation analyses and alpha/beta determinations. This LLD corresponds to that amount of activity in a sample that will yield a net count greater than 3.29 Sb, i.e., the so-called Critical Level (CL), with 99% probability.
The LLD specifies the theoretical capability of the system to quantify a given amount of radioactivity, whereas the CL is used to determine in practice whether a single activity measurement should be considered "detected". Any individual measurement greater than 3.29 Sb is considered detected at the 99% confidence level. This also implies a 1% probability of stating that activity is present when it is not (false positive). If activity is present at the LLD level (6.58 Sb) there is a 1% probability of stating that activity is not present when it is (false negative).
In most of the tables of data (Section 3.0), it is this Critical Level that appears in column 1. Where there are sufficient background data to provide a well defined background as for example with the TLD data, the CL is defined as 2.33 Sb and the LLD as 4.66 Sb.

2) Unless otherwise indicated, the precision of the measurements reported here is given as $\pm$ 1.96 Sa (95% confidence level), where Sa is the standard deviation of the activity measurement.

3) The value and standard deviation are reported with two significant figures using modified scientific notation, for example 0.032 is expressed as 3.2E-02.

8.3 Analytical Techniques

The major analytical techniques and the instruments used in routine environmental analysis are summarized in Table 8.01. In the case of gamma spectrometry analysis, all significant peaks in the spectrum are identified either by reference to a library of about 100 radionuclides in a computer file, or by manual reference to compilations of all known radionuclides. In addition, approximately 20 'selected' radionuclides are specifically searched for in every sample with the exception of Air Iodine samples in which only I-131 is 'selected'. The 'selected' radionuclides include those which are produced in PLGS and which would be readily detectable because of their abundance (high fission yield) and high branching ratios for gamma emissions. Naturally occurring gamma emitters - daughter radionuclides of uranium and thorium; cosmogenic radionuclides and any of the 18 or so known radioactive species found in nature - are present in most samples, but with the exception of Be-7, K-40 and Ac-228 are not included in this report. The latter radionuclides are sometimes useful as general indicators of the consistency of the analytical techniques and are thus reported.

The usefulness of alpha/beta analysis lies primarily in screening samples to determine whether or not more detailed analyses should be performed. The reported alpha and beta values are assessed using Am-241 and Sr-Y-90 calibration sources respectively.

Wet chemical analyses for Sr-90 on Gaseous Effluent (airborne) Monitoring (GEM) and Liquid Effluent Monitoring (LEM) samples covering the entire year indicated that emissions of Sr-90 in 1989, were sufficiently low (generally below the LLD), that it would be pointless to analyze environmental samples in the expectation of seeing this radionuclide.

TABLE 8.01

SUMMARY OF ANALYTICAL TECHNIQUES

Analytical technique	Instrumentation
Gamma Spectroscopy	A Canberra 24% efficient * intrinsic germanium detector, in an Applied Physical Technology 10 cm graded lead cave. A NaI (7.6x7.6 cm) detector in an APT 10 cm graded lead cave. Ortec Model 7010 multichannel analyser (4096 channels). Hewlett-Packard 9845B microcomputer for automatic data reduction (20 megabyte hard disc storage capacity).
Liquid Scintillation (Tritium and C-14)	Beckman LS-100C counter
Gross Alpha/Beta and Sr-90 Analyses	Tennelec LB-5100 alpha/beta detector.
Thermoluminescence Dosimetry	Panasonic UD-710A Automatic TLD Reader and UD-814AQ dosimeters.
Chemical analysis, Ion exchange separation	Laboratory separation and analysis for Sr-90 on various sample types. The final analysis is by Tennelec alpha/beta counting.

* relative to a sodium iodide detector of the same size.

8.4 Sample Collection, Analysis and Detection Limits

8.4.1 Airborne Particulates

Collection

Airborne particulates are collected on a 47 mm diameter Gelman Type A glass fibre filter through which air is drawn at up to 60 L/min (approximately 2 400 m^3 for a 28 day continuous sample). The volume of air sampled is measured with an in-line integrating dry gas meter. Every four weeks the filters are replaced and the used ones returned to the laboratory for analysis. Sampling is therefore continuous throughout the year, the only interruption, other than because of power failure or pump breakdown, being the five minute filter change. About 2% of collection time was lost due to breakdown and power failures.

Analysis and Detection Limits

Air particulate filters are analyzed by gamma spectrometry as soon as possible after collection to ensure detection of any short lived gamma emitters that may be present, and to minimize any decay corrections. Samples are counted for 5 000 s on a 24% efficient intrinsic germanium gamma spectrometer. Typical LLDs are given in Table 8.02 for a 1 200 m^3 sample. The LLDs are decay corrected to the time of sample collection. Throughout this section and in the data tables, the radionuclides are listed in order of increasing 'selected' photon energy, (exceptions to this are the additional data for gross alpha, gross beta, tritium and Ru-106). Ruthenium-106 is a pure beta emitter only, but is a long lived parent of the short half life Rh-106 which is used for the analysis. Decay corrections are based upon the parent half life.

Approximately three days after the end of the sample collection, each filter is counted for 100 minutes for the simultaneous determination of gross alpha and gross beta activity. Counting is delayed for this length of time to allow for the decay of activity of the short-lived naturally occurring radon daughters which are present in all of these samples and which would otherwise complicate the analysis.

TABLE 8.02

LLDs ON AIR PARTICULATE SAMPLES

Nuclide	LLD (Bq/m^3)
Gross alpha	4E-05
Gross beta	8E-05
Ce-144	1E-03
Ce-141	4E-04
Cr-51	2E-03
I-131	4E-04
Be-7	4E-03
Ru-103	2E-04
Ba-140	1E-03
Cs-134	2E-04
Ru-106	2E-03
Cs-137	2E-04
Zr-95	4E-04
Nb-95	2E-04
Co-58	2E-04
Mn-54	2E-04
Ag-110m	4E-04
Ac-228	8E-04
Fe-59	6E-04
Zn-65	8E-04
Co-60	4E-04
K-40	6E-03
La-140	4E-04

8.4.2 Airborne Radioiodine

Collection

Airborne radioiodine is collected in an activated charcoal cartridge placed downstream from the glass fibre filter used to collect the airborne particulates. The cartridges used are Nuclear Consulting Services NUSORB (47 mm diameter and 48 mm length) charcoal cartridges containing 5% $TEDA_3$ by weight. For a 28 day continuous sample approximately 2 400 m^3 of air is sampled at a flow rate of 60 L/min. The volume of air sampled is measured with an in-line integrating dry gas meter.

Analysis and detection limits

Iodine-131 is the major nuclide of interest on the charcoal cartridges. To more efficiently use the available counting time, the cartridges are analyzed in groups of four, for 50 000 s on the gamma spectrometer as soon as possible after collection because of the relatively short half life of I-131 (8 days). If

radioiodine is detected, then the cartridges are re-analyzed individually and an activity per cubic metre assigned to corresponding locations. Other fission product radioiodines, with much shorter half lives (minutes to hours), decay before they reach the sample location or during the time the sample is being collected.
A typical LLD for I-131 is about 3E-05 Bq/m^3 of air. This is an order of magnitude improvement over the previous counting strategy where samples were analyzed individually for 5 000 s. If a significant release of radioiodine were noted from the station in this interval, the samples would be changed and analyzed earlier to avoid inappropriate decay corrections.

8.4.3 Airborne Tritium

Collection

A fraction of the flow in the air monitoring sample train is diverted through a molecular sieve container where water vapour is trapped. The volume of air passed through the molecular sieve is measured with an in-line integrating dry gas meter. The sieve material is later heated to 450°C to drive off absorbed water which is then condensed and collected for analysis. Sampling is continuous at each location throughout the year, but is interrupted for a few minutes every four weeks to exchange sieve containers. Since the amount of water absorbed by the molecular sieve from a given volume of air depends upon relative humidity, flow rates are adjusted seasonally (using a Dwyer flow meter) to avoid saturation of the sieve material and to ensure adequate sample collection.

Analysis and Detection limits

For tritium analysis by liquid scintillation techniques, 6 mL of water taken from the molecular sieve are mixed with 15 mL of Aquasol-II, and counted for 100 minutes. The LLD is approximately 1E-01 Bq/m^3 of air for a typical sample, corresponding to about 1E-03% of the tritium DAC for the general public.

8.4.4 Airborne Carbon-14

Collection

Airborne carbon dioxide is collected in a 1 L volume of 2 N caustic soda solution at two environmental monitoring locations. One is at the Lighthouse location (G02), and the other is at the Information Centre (H04). The volume of air sampled is assessed by gravimetric analysis of the dissolved carbon dioxide precipitated from solution as barium carbonate.

Analysis and Detection Limits

Carbon-14 is determined by liquid scintillation analysis of a 6 mL aliquot of the solution in 15 mL of Aquasol-II. The LLD is about 0.5 Bq/m^3 of air.

8.4.5 Environmental Gamma Radiation

Thermoluminescence Dosimetry (TLD)

Environmental gamma radiation is measured by thermo-luminescence dosimetry for each of 37 locations on a quarterly basis. The phosphor is contained in a holder comprising three elements of lead-filtered calcium sulphate and one of lithium borate. The assembly, heat sealed in plastic and further protected in a thin walled plastic bag, is suspended about 1 m above the ground. The LLD at the 99% confidence level (i.e., 4.66 standard deviations above a well defined background) is approximately 10 microgray. All background radiation measurements are considerably higher than this.
The expected precision is about ± 10% at the 95% confidence level.

Measurements of the ambient radiation levels in the Point Lepreau area are given in Table 3.05A. The data in the 'Total' column are rounded to the nearest ten. If a quarterly measurement is not available (lost TLD, moisture penetration, etc.) a mean value is calculated from the available measurements in order to provide an estimate for the annual total.
The statistical uncertainty shown in the Total column is the square root of the sum of the squares of the uncertainties of the individual quarterly measurements. A summary of TLD results since 1978 is given in Table 3.05B.

Environmental Dose Rate Survey Measurements

Gamma dose rate measurements (Beach Surveys) are taken quarterly on beaches and mud flats in the Point Lepreau area with an environmental gamma survey meter (Nuclear Enterprises type PDR1 or equivalent, capable of determining ambient radiation levels down to about 0.05 microgray/hour). In these inter-tidal locations it would be impracticable to use TLDs.

8.4.6 Sediment

Collection and preparation

Beach and mudflat sediments (sand, silt and clay) are collected near the low tide mark with preference being given to the top 50 mm of the finely-divided silts characteristic of tidal mud flats. Disposable polyethylene containers are used to collect

about 2 kg of sample which is later transferred to disposable aluminum trays for drying. Dried caked samples are broken into their original free granular form with a porcelain mortar and pestle and sieved through a 0.2 mm sieve to collect the fines for analysis (a 1 mm sieve is used for coarse sediments).

Analysis and Detection Limits

Approximately 0.25 kg of dried sediment is counted for 5 000 s on the gamma spectrometry system.

TABLE 8.03

LLD IN SEDIMENT

Nuclide	LLD (Bq/kg)
Ce-144	2E+01
Ce-141	8E+00
Cr-51	4E+01
I-131	8E+00
Be-7	4E+01
Ru-103	2E+00
Ba-140	2E+01
Cs-134	4E+00
Ru-106	4E+01
Cs-137	6E+00
Zr-95	6E+00
Nb-95	2E+00
Co-58	2E+00
Mn-54	4E+00
Ag-110m	4E+00
Ac-228	4E+01
Fe-59	6E+00
Zn-65	4E+00
Co-60	4E+00
K-40	2E+01
La-140	1E+01

8.4.7 Soil

Soil samples were not analyzed in 1989.

8.4.8 Water (Well Water/Sea Water)

Collection and Analysis

A 4 L sample of well water or sea water is collected and acidified with 15 mL of concentrated Nitric acid. About 20 mL of

each sample, taken out before acidification, are used for tritium analysis (the sea water is distilled). Well water samples (125-500 mL, depending upon the dissolved solids content) are evaporated to dryness on stainless steel planchets for gross alpha/beta analysis.
Other water samples collected and analyzed include those at the SRWMF, i.e., Bore Hole waters, Cell Drainage water (if present) and surface run-off collected in the Parshall Flume. Lagoon water samples from within the PLGS exclusion boundary are also analyzed.

Analysis and Detection Limits

For gross alpha/beta analysis of well water, dried samples are counted for 100 minutes on a Tennelec LB-5100 alpha/beta counting system.
For tritium analysis, a 6 mL sample of fresh water or sea water distillate is mixed with 15 mL of Aquasol-II and counted for 100 minutes by liquid scintillation. For gamma spectrometry analysis a 3.6 L sample is counted for 5 000 s on the gamma spectrometer. Typical LLDs are listed below.

TABLE 8.04

LLD IN WELL WATER AND SEA WATER

Nuclide	Well Water LLD (Bq/L)	Sea Water LLD (Bq/L)
Gross alpha	1E-01	NA
Gross beta	1E-01	NA
H-3	4E+01	4E+01
Ce-144	2E+00	4E+00
Ce-141	1E+00	6E-01
Cr-51	4E+00	4E+00
I-131	4E-01	4E-01
Be-7	4E+00	2E+00
Ru-103	4E-01	4E-01
Ba-140	2E+00	2E+00
Cs-134	4E-01	4E-01
Ru-106	4E+00	2E+00
Cs-137	4E-01	4E-01
Zr-95	6E-01	6E-01
Nb-95	4E-01	4E-01
Co-58	4E-01	4E-01
Mn-54	4E-01	4E-01
Ag-110m	6E-01	4E-01
Ac-228	1E+00	1E+00
Fe-59	1E+00	8E-01
Zn-65	8E-01	6E-01
Co-60	6E-01	4E-01
K-40	1E+01	4E+00
La-140	1E+00	6E-01

NA - Not applicable. Sea water contains relatively high levels of natural radioactivity from K-40 and large amounts of dissolved salts which would interfere with these determinations.

8.4.9 Milk

Collection

A 4 L sample of milk is collected for gamma spectrometric analysis and if necessary preserved by addition of 15 mL of formaldehyde solution, 37% w/w. Distillate from an aliquot of the same sample, before addition of preservative, is used for tritium analysis.

Analysis and Detection Limits

For tritium analysis by liquid scintillation techniques, a 6 mL sample of distillate is mixed with 15 mL of Aquasol-II and counted for 100 minutes.

For gamma spectrometric analysis, a 3.6 L sample is analyzed for 50 000 s (overnight) on a 24% efficient intrinsic germanium detector. Typical LLDs for the nuclides of interest in milk are listed below.

TABLE 8.05

LLD IN MILK

Nuclide	LLD (Bq/L)
H-3	4E+01
Ce-144	1E+00
Ce-141	2E-01
Cr-51	1E+00
I-131	1E-01
Be-7	1E+00
Ru-103	1E-01
Ba-140	8E-01
Cs-134	1E-01
Ru-106	1E+00
Cs-137	2E-01
Zr-95	2E-01
Nb-95	2E-01
Co-58	2E-01
Mn-54	2E-01
Ag-110m	1E-01
Ac-228	6E-01
Fe-59	4E-01
Zn-65	4E-01
Co-60	2E+00
K-40	2E+00
La-140	2E-01

8.4.10 Seafood

Collection and Preparation

Approximately 0.5 to 2 kg of fresh seafood is collected for analysis as available. The crabs and lobsters are cooked before analysis to facilitate removal of the meat and ensure close packing in the analytical container. Whole, uncooked periwinkles (not available from suppliers in 1989) and clams are analysed, but the analysis is attributed only to the flesh weight of the

sample (about 25% of the total). In previous years only the edible fraction of these species was analyzed as for crabs and lobsters. Dulse (Rhodymenia palmata) is the most commonly harvested edible seaweed in the Point Lepreau area. Irish Moss, (Chondrus crispus), is commercially important in other areas of the Bay of Fundy, i.e., St. Mary's Bay, but is not harvested in the Point Lepreau area.
Other species of seaweed, e.g., Laminaria and Ascophylum have been examined for their commercial possibilities, but they are not currently harvested.

Analysis and Detection Limits

Approximately 0.25 kg of each prepared sample is counted for 5 000 s on a 24% efficient gamma spectrometer. Typical LLDs are given below.

TABLE 8.06

LLD IN SEAFOOD (EDIBLE FRACTION)

Nuclide	LLD (Bq/kg)
Ce-144	1E+01
Ce-141	4E+00
Cr-51	1E+01
I-131	2E+00
Be-7	2E+01
Ru-103	4E+00
Ba-140	4E+00
Cs-134	2E+00
Ru-106	1E+01
Cs-137	2E+00
Zr-95	2E+00
Nb-95	2E+00
Co-58	2E+00
Mn-54	2E+00
Ag-110m	2E+00
Ac-228	8E+00
Fe-59	4E+00
Zn-65	4E+00
Co-60	2E+00
K-40	2E+01
La-140	2E+00

8.4.11 Vegetation

Collection and Preparation

The only vegetation types routinely collected and analyzed are tree lichen (Spanish moss) and various ground mosses such as

Cladonia and Lycopodium. About 100 g or more of each of the samples is collected and air dried before analysis. No special preparation is required. Reference samples are collected from the Fredericton area.

Analysis and Detection Limits

Samples are analyzed for 5 000 s on a 24% efficient gamma detector. Typical LLDs for a 100 g sample of lichen are given below.

TABLE 8.07

LLD IN VEGETATION

Nuclide	LLD (Bq/kg)
Ce-144	4E+01
Ce-141	1E+01
Cr-51	5E+01
I-131	9E+00
Be-7	5E+01
Ru-103	7E+00
Ba-140	3E+01
Cs-134	2E+01
Ru-106	6E+01
Cs-137	7E+00
Zr-95	8E+00
Nb-95	1E+01
Co-58	6E+00
Mn-54	4E+00
Ag-110m	8E+00
Ac-228	2E+01
Fe-59	8E+00
Zn-65	1E+01
Co-60	6E+00
K-40	4E+01
La-140	2E+01

9.0 ENVIRONMENTAL REPORTS OF PREVIOUS YEARS

PRE-OPERATIONAL (1975 - 1982)

1 Pre-Operational Radiological Environmental Monitoring Program for Point Lepreau Nuclear Generating Station. NBEPC-HP-75-1. J.A. Flanigan. 1975.

2 Pre-Operational Environmental Radiation Monitoring Data for Point Lepreau Generating Station. October 1, 1976 to June 30, 1979. NBEPC-HP-79-1. J.A. Flanigan and J.J. Paciga. Sept. 1979.

3 Pre-Operational Environmental Radiation Monitoring Data for Point Lepreau Generating Station. January 1, 1979 to December 31, 1979. NBEPC-HP-80-1. J.A. Flanigan. Sept. 1980.

4 Pre-Operational Environmental Radiation Monitoring Data for Point Lepreau Generating Station. January 1, 1980 to December 31, 1980. NBEPC-HP-81-1. J.K. Sutherland and J.A. Flanigan. July 1981.

5 Pre-Operational Environmental Radiation Monitoring Data for Point Lepreau Generating Station. January 1, 1981 to December 31, 1981. NBEPC-HP-82-1. J.K. Sutherland. February 1982.

OPERATIONAL (1982 - 1986)

6 Operational Environmental Radiation Monitoring Program. Revision 1, January 1982. RD-01364-L15. J.K. Sutherland.
Revision 2, June 1983.
Revision 3, September 1985.

7 Environmental Radiation Monitoring Data for Point Lepreau Generating Station. January 01, 1982 to December 31, 1982. HP-07000-83-1. J.K. Sutherland. March 1983.

8 Environmental Radiation Monitoring Data for Point Lepreau Generating Station. January 01, 1983 to December 31, 1983. HP-07000-84-1. J.K. Sutherland. February 1984.

9 Environmental Radiation Monitoring Data for Point Lepreau Generating Station. January 01, 1984 to December 31, 1984. HP-07000-85-1. J.K. Sutherland. February 1985.

10 Environmental Radiation Monitoring Data for Point Lepreau Generating Station. January 01, 1985 to December 31, 1985. HP-07000-86-1. J.K. Sutherland. March 1986.

11 Environmental Radiation Monitoring Data for Point Lepreau Generating Station. January 01, 1986 to December 31, 1986. HP-07000-87-1. J.K. Sutherland. February 1987.

12 Environmental Radiation Monitoring Data for Point Lepreau Generating Station. January 01, 1987 to December 31, 1987. HP-07000-88-1. J.K. Sutherland. February 1988.

13 Environmental Radiation Monitoring Data for Point Lepreau Generating Station. January 01, 1988 to December 31, 1988. HP-07000-89-1. J.K. Sutherland. February 1989.

10.0 DISTRIBUTION LIST

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